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ABSTRACT

Instructional materials provided for five areas of agricultural education: animal science, soil science, plant science, agricultural mechanics, and agricultural management. Animal science consists of four units on animal reproduction, livestock, wildlife, and livestock facilities. The three units on soil science are reading and interpreting soil maps, managing soils, and utilizing agencies that assist in soil and water conservation. The section on plant science has three units on plant breeding, harvesting, and identification and selection of fruits, vegetables, and ornamental plants. Agricultural mechanics contains five units: farm electricity, agricultural power, tractor maintenance, farm water supply and sanitation, and farm level. Agricultural management has eight units: an introduction, principles of economics, agricultural finance, agricultural planning, agricultural records, agricultural insurance, marketing, and agricultural programs and services. Each unit contains from one to eight topics. For each topic informative materials, narratives for transparencies, a list of references, and transparency masters are provided. Glossaries may be provided for a topic or for an entire section. (YLB)

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V.A. III
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Revised: January, 1983

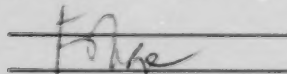
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ANIMAL SCIENCE

Unit A: Animal Reproduction

Topic 1: Genetics

Note: All terms underlined are included in the "Glossary of Terms."

1. Introduction to Genetics

Genetics has been defined as a study of why we are what we are. It has also been described as a study which deals with the differences and similarities among individuals related by descent.

Differences within given species were observed in very early times. Early breeders discovered that through selection plants and animals could be improved. The wide range of traits found in livestock today was developed by selection and breeding.

George Mendel, a monk and an untrained scientist, discovered the process of inheritance while pursuing his hobby of breeding peas. However, Mendel's work was not recognized until after his death when his findings were duplicated by Corners, de Vries, and von Tschernak in 1900.

A knowledge of genetics is important to the livestock producer. Through the use of knowledge, selection, and breeding, the producer can develop animals with traits that make them more desirable to consumers, increase production, and change physical appearance and temperament. The producer, however, must be aware that environment also affects many of the traits found in animals.

2. The Cell and Cell Division

An animal's body is made up of millions of tiny structural units called cells. Some cells are so small that if laid side by side, it would take 250,000 of them to measure an inch. Animal life starts from a single, fertilized cell. The cell is the basis for improving animals and has many different shapes.

Transparency No. 1

A cell is composed of a cell wall and protoplasm, and protoplasm consists of a nucleus and cytoplasm. The nucleus contains chromatin which forms bodies

called chromosomes. The chromosomes carry minute cells called genes, which determine the hereditary characteristics of animals and are transmitted to the offspring from the parents. All animals of the same specie have the same number of chromosomes and all animals have millions of genes. It is because of these millions of genes and possible combination of these genes that no two animals are alike.

The number of chromosomes found in the cell of man and common animals are as follows:

Man	46	Goat	60
Swine	80	Mouse	40
Cattle	60	Rat	42
Sheep	54	Chicken	78
Horse	60		

Growth in animals is largely due to an increase in the number of cells rather than cell size. As cells divide, the animal increases in size (grows).

Transparency No. 2

The above transparency shows the steps in cell division. A cell divides into two cells, then these two cells divide into four cells, and so on until an animal becomes an adult. The division of cells is called mitosis.

3. Methods of Reproduction

The two general methods of reproduction are sexual and asexual. All domestic animals reproduce by the sexual method of reproduction, which involves the union of a sperm and an egg. Bacteria and some plants are reproduced by the asexual method, which is performed by a single division of a cell.

New individuals are produced from productive cells, often called germ-cells or gametes. Male germ-cells are called sperms or spermatozoa, while female germ-cells are called eggs or ova.

Transparency No. 3

Before the male and female germ-cells unite, they go through a process called maturation, a process where the chromosomes in both the male and female germ-cells are reduced to one-half of the original number. The maturation process in the male and female germ-cell are different. Only one in four of the female germ-cells are productive, while all of the male germ-cells will reproduce after uniting with an egg.

4. The Sperm and the Egg

The volume of semen and the number of sperms are influenced by the sexual use, health of the male, season of the year, the age of the male, and the specie. By volume of semen per animal, the boar, stallion, bull, ram, and rooster would be ranked in that order. Ranking them on the average sperm concentration per service, the above mentioned animals would be ranked as follows: rooster, bull, ram, boar, and stallion. The average number of sperm cells in a single service runs into the millions.

Transparency No. 4

The sperm is very small and must be magnified many times before it is visible. Because the egg contains the food material for the developing young, it is much larger than the sperm. Some eggs are as large as $1/135$ of an inch in diameter. The sperm and egg are the parent germ-cells and transmit all the characters that the offspring will inherit.

The number of offspring produced by the female will give an indication as to the number of eggs produced by a specie. A sow produces more eggs than a cow. All of the eggs produced by an animal are not fertilized. Sometimes a fertilized egg will separate into two parts, and each part will form an individual. These individuals are of the same sex, have similar features, and are called identical twins. Twins developed from separate fertilized eggs are referred to as fraternal twins and are not identical.

5. Dominant and Recessive Characteristics

A character is a trait or feature such as horns in cattle and the hair color in a certain breed of horses. The character itself is not present in the cell, but the cell has the ability (or that something) to produce the character. This something that produces character and affects its development is known as a factor or gene. All characters are not visible; and some are hidden by presence of others. An example is an animal that contains both polled and horned genes. The polled character is visible. The gene that hides another gene is said to be recessive. The dominant factor is designated by capitalizing the first letter of the factor, and the recessive factor is designated by using the lower case of the first letter of the dominant factor. For example, the dominant factor for polled would be designated by a P and the recessive factor, which is horned, would be designated with a p. A list of dominant and recessive factors is as follows:

Dominant

Recessive

Poultry

Rose Comb
White Shanks
Feathered Shanks
Black Plumage

Single Comb
Yellow Shanks and Skin
Clean Legged
White Plumage

Cattle

Normal Size
Black Body
White Face
Polled
Dark Color

Dwarf
Red Body
Black Face
Horned
Light Color

Sheep

Polled
White Fleece

Horned
Black Fleece

Swine

Lopped Ears
Mule Foot
White Hair

Fox Ears
Normal Foot
Red and Black Hairs

Horses

Black Color
Gray Color

Chestnut

6. Transmission of Characters

An individual that possesses both genes for a character is pure or homozygous for that character, while an individual that has genes which affect a character differently is impure or heterozygous for that character. Using the polled and horned characters as an example, the homozygous character for polled would be written PP and the heterozygous character is written as Pp. One should not confuse a purebred or an animal subject to registration with the word homozygous, which is used to indicate the genetic composition for any given character. Many registered animals are probably heterozygous for many genes.

As was mentioned in the discussion of the maturation process, the number of chromosomes in both the male and female germ-cells is reduced to one-half the original number. During this process, the gene pairs separate and go to different gametes. Therefore, after maturation only a single gene for a character is present in the reproductive cell, even though two genes for that character are always present in the fertilized egg or in the body cells of an individual (except for sex-linked characters which will be mentioned later).

Transparency No. 5

The above transparency shows two genes, representing the ear character in swine, (LL or Ll) dividing during the maturation process. Genes L and l are

known as alleles.

When recessive and dominant genes are united in the F1 generation, the dominant characters are carried by the progeny. Some of the animals in the F2 generation will show dominant characters and others will show recessive characters.

Transparency No. 6

The "square" or "checkerboard" diagram (in the above transparency) is used to determine the probable results in breeding livestock. The male germ-cells are indicated in one margin (usually across the top) and the female germ-cells are indicated in the other margin. A cross between a bull homozygous for polled condition (PP) and cow homozygous for horned condition (pp) will produce only polled offsprings in the F₁ (Fig. 1).

The offsprings from individuals heterozygous for the polled character (Pp) will be in the approximate ratio of three polled to one horned (Fig. 2). This is influenced by chance. The horned individuals produced from this cross (lower right-hand block, Fig. 2 in transparency) will not carry a gene for the polled character even though both parents were polled.

Using the information furnished above, one may wish to determine which animals in his herd are homozygous for the polled character. To determine if a polled bull is homozygous for the polled character, the bull should be bred to horned cows. If he is pure, his offsprings will be polled. From a bull with a heterozygous polled character, one-half of the calves will be horned and one-half will be polled. The above information may also be used to determine whether animals are homozygous or heterozygous for other characters.

A character can be the result of incomplete dominance. Roan color in Shorthorn cattle is the result of incomplete dominance of red and white. In this case, capital letters are used to designate each gene (R = red; W = white).

Transparency No. 7

Breeding Shorthorn animals as shown in Figure 1, would produce offsprings which would all be roan. The crossing of roan and white individuals, as shown in Figure 2, would produce offsprings in the approximate proportion of two roan to two white.

Up until now, single characters are all that have been considered. There are a number of characters in any cross. One could expect a ratio of 3:1 based on appearance in the offsprings of a cross between individuals heterozygous for a dominant character. The expected ratio with two pairs of heterozygous characters would be 9:3:3:1. With each additional character the ratio is changed to the extent

of multiplying the preceding ratio by 3:1.

Transparency No. 8

Crosses between individuals impure for both horned and whitefaced conditions (Pp Ww) should give a ratio of nine polled, whitefaced; three polled, colored faced; three horned, white faced; and one horned, colored faced. One can see that breeding animals to improve a particular character is complicated.

7. Determination of Sex

Sex of an animal is determined at the time of fertilization. The female has, in addition to the regular chromosomes, two sex chromosomes, designated by the letters XX. In the male only one sex chromosome (X) is present, and the other is designated as Y.

Transparency No. 9

After maturation one-half of the sperms and all of the eggs carry an X chromosome. The other one-half of the sperms carry a Y chromosome.

If in fertilization, a sperm carrying an X chromosome unites with an egg the offspring will be a female (XX). If a sperm carrying a Y chromosome unites with an egg, the offspring will be a male (XY).

In poultry the male carries two sex chromosomes, while the female carries only one. These are usually referred to by the letters Z and W. The letter W is used to indicate the sex chromosome in the female. Thus, the male would be designated as ZZ and the female as ZW. After maturation all of the sperms carry a Z chromosome, but only one-half of the eggs would carry Z. The square, as explained under Transparency No. 6, may be used to determine the sex.

8. Sex-Linked Characters, Crossing-Over, and Mutation

Certain genes located on the X or Z chromosomes are referred to as sex-linked. These characters may be used to determine the sex of an animal. For example, the barring of Barred Plymouth Rock chickens is a sex-linked character. If barred hens are mated with nonbarred males, all the barred chicks from this cross are males (ZBZb) and the nonbarred chicks are females (ZbW). There are other sex-linked characters.

In some cases there is an interchange of the entire segment of certain chromosomes as a result of crossing-over.

Occasionally, something will change a gene, and an individual is produced with a new character, a mutation.

9. Improving by Selection

Regardless of the breeding system followed, permanent improvements in livestock are usually the result of selection. The two kinds of selection are natural and artificial. Natural selection is the selection made of wild animals, while artificial selection is the selection made by man.

Since selection is the principal means of improving animals, one must be aware of the factors that cause variations which are environment, recombination of characters, and mutation.

Environmental factors that cause variations in animals are climate, amount and kinds of feed available, and methods of feeding. Animal selection certainly should not be based on factors that are influenced by environment.

Recombination of characters is one of the major causes of differences between animals. These differences are caused by the production of germ-cells with different characters. Selection based on these differences is permanent and is the best means of improving animals.

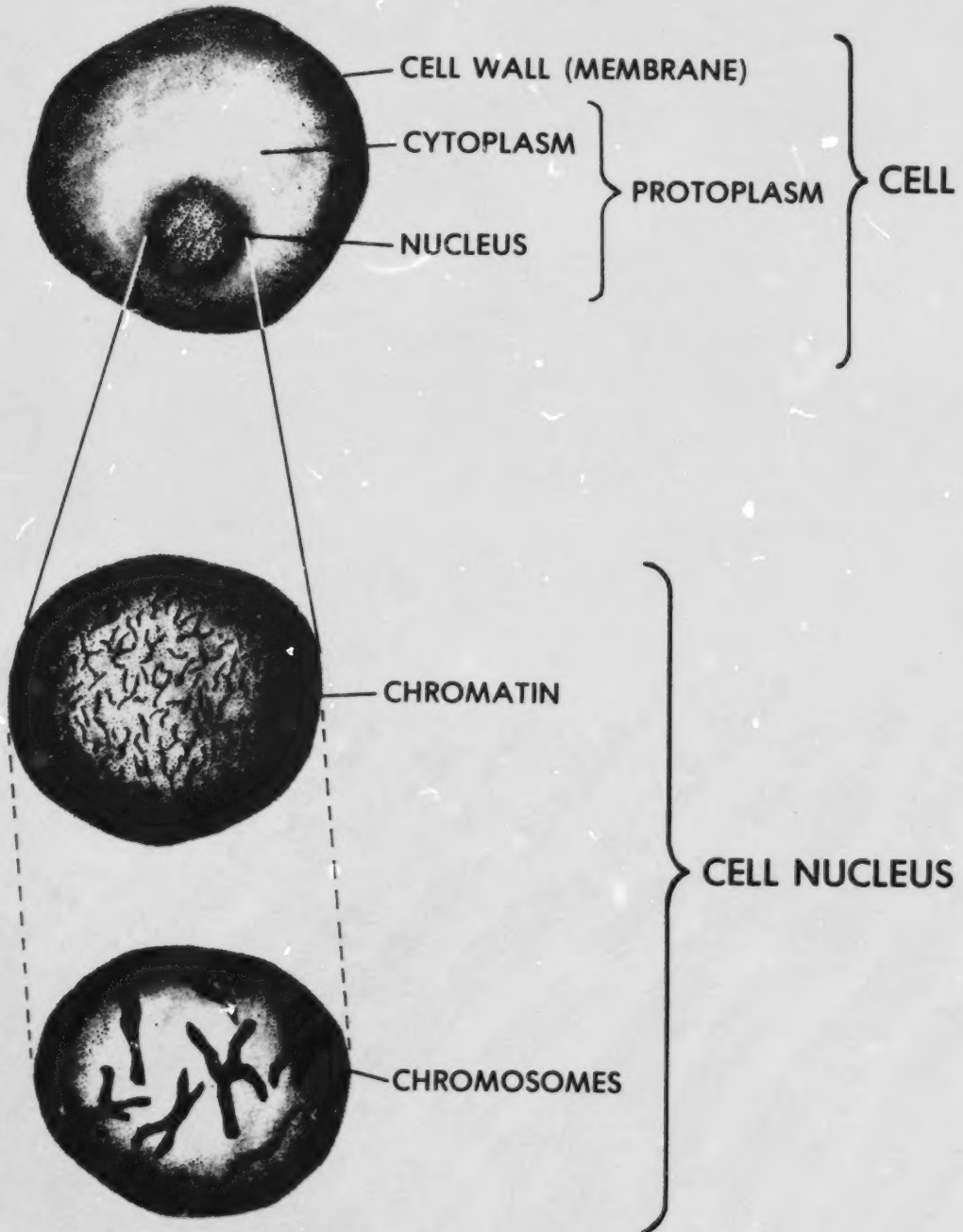
The third cause of variation is mutation. Selection based on a mutation is permanent. However, most mutations are not beneficial and progress is slow.

There are several methods of selecting animals which have been discussed in detail in other V.A.III materials.

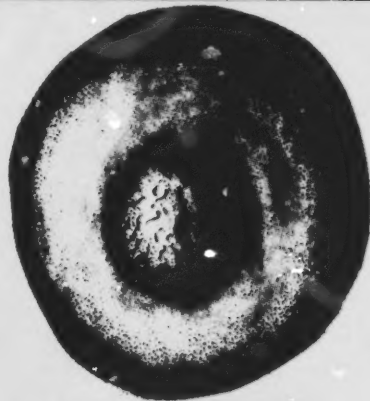
References:

1. "Improving Animals Through Breeding", Vocational Agriculture Service, Urbana, Illinois.
2. Ensminger, M. E., Animal Science, The Interstate Printers and Publishers, Inc., Danville, Illinois, 1969.

PARTS OF AN ANIMAL CELL



STEPS IN CELL DIVISION IN GROWTH (MITOSIS)



RESTING CELL



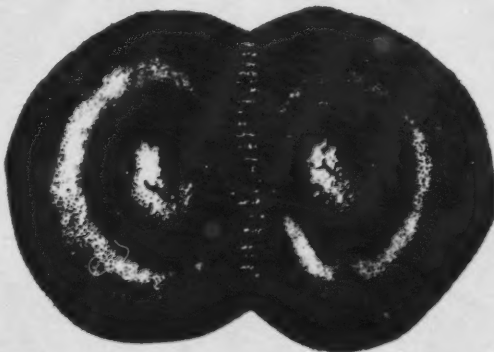
CHROMOSOMES FORMING



CHROMOSOMES DIVIDING



CHROMOSOMES AND
NUCLEUS SEPARATING



CELL DIVIDING



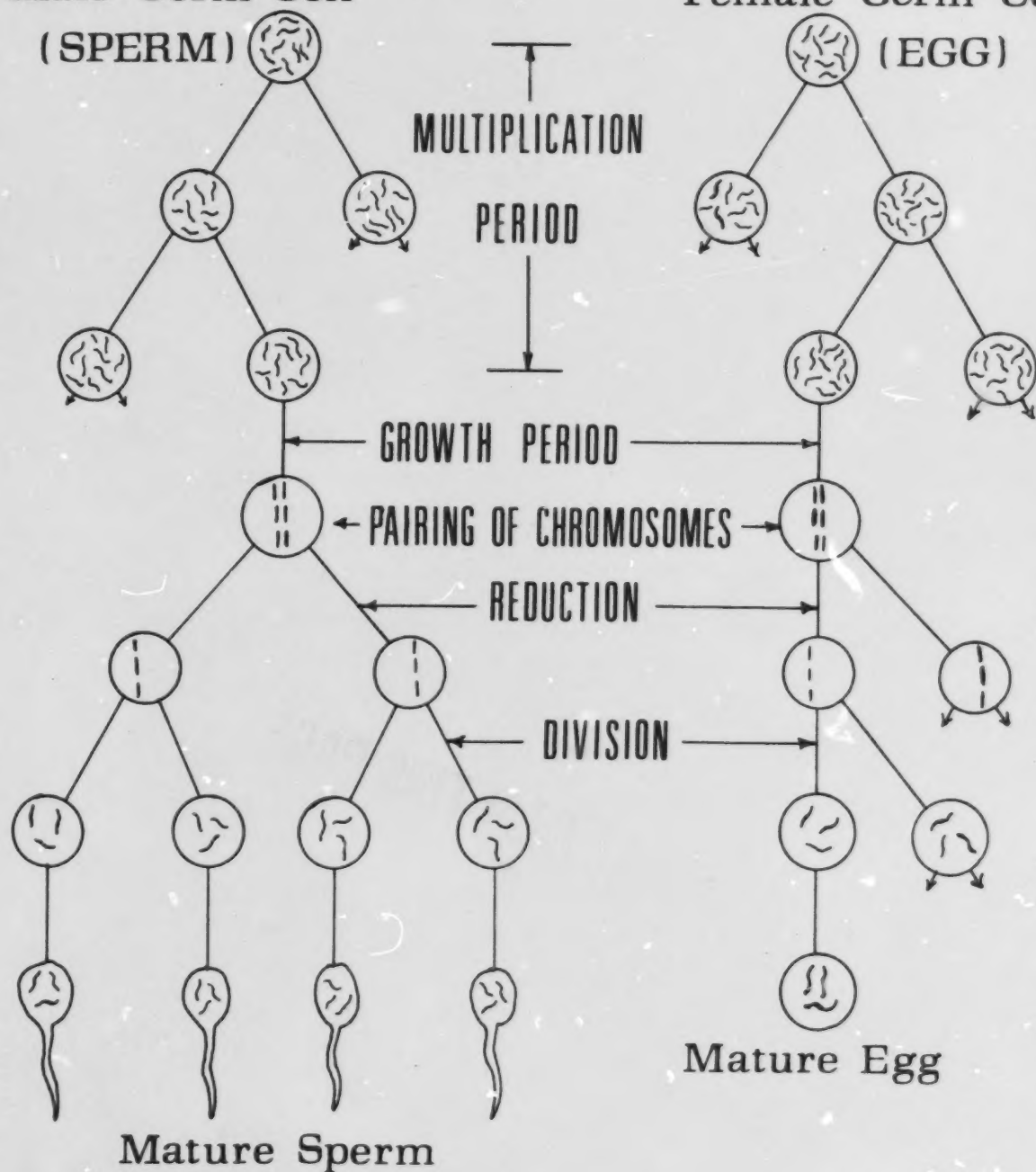
TWO CELLS FORMED



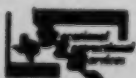
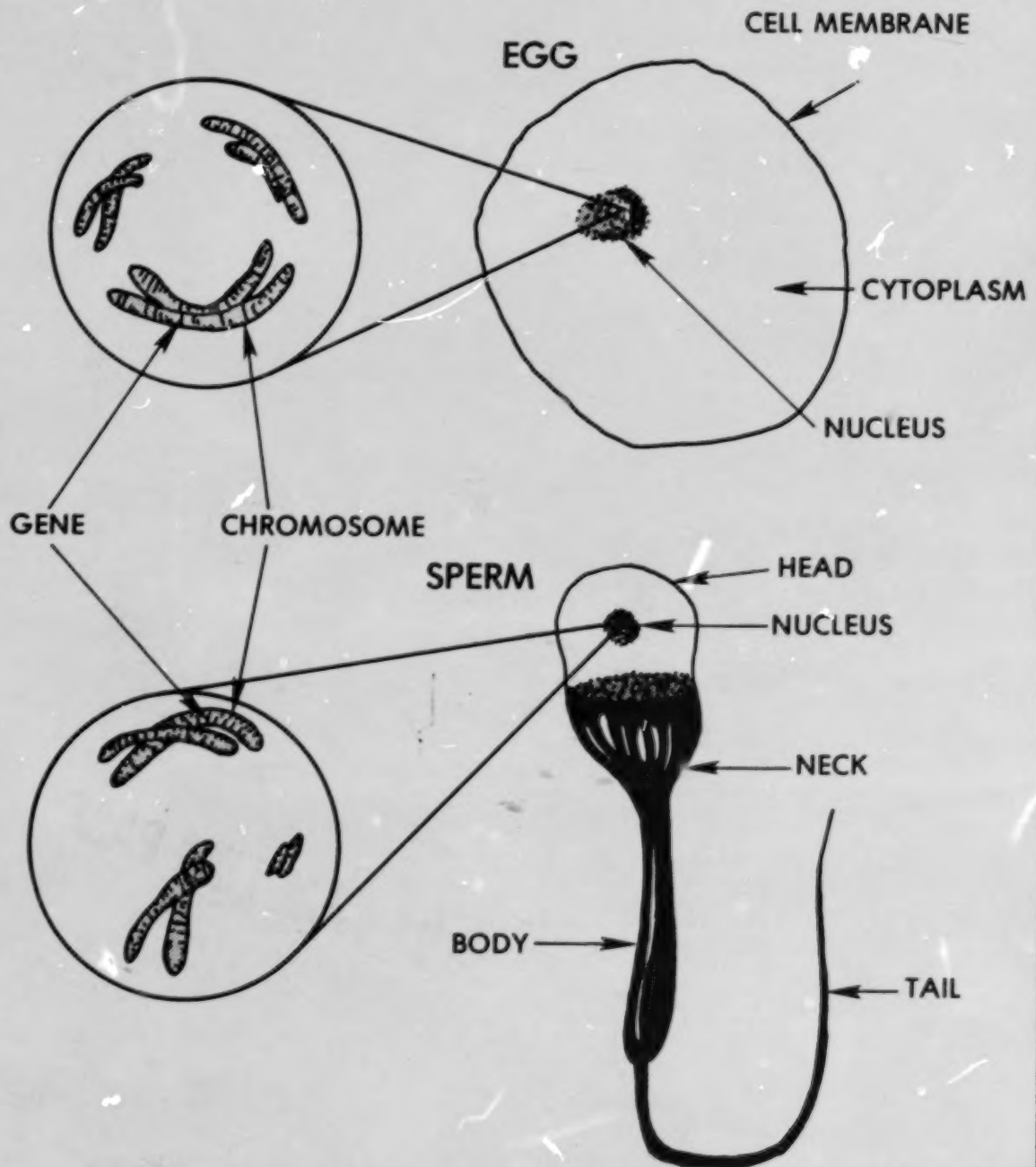
MATURATION PROCESS (MEIOSIS)

Male Germ Cell
(SPERM)

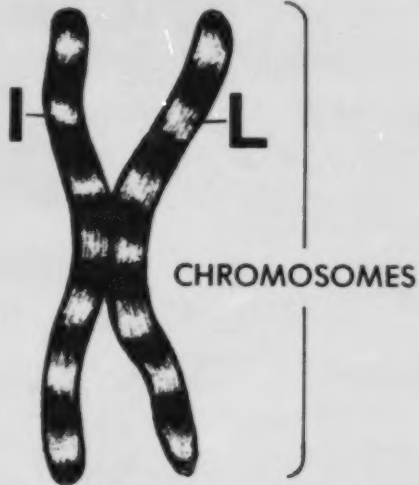
Female Germ Cell
(EGG)



ANATOMY OF THE EGG & SPERM



AN EXAMPLE OF GENE PAIRS DIVIDED



GENES AND
CHROMOSOMES PAIRED

GENES AND
CHROMOSOMES DIVIDING
(MEIOSIS)

I - gene for erect
ear trait (recessive)

L - gene for lopped
ear trait (dominant)



GAMETES FORMED
SHOWING GENOTYPE



PROBABLE RESULTS FROM A DOMINANT AND RECESSIVE CHARACTER

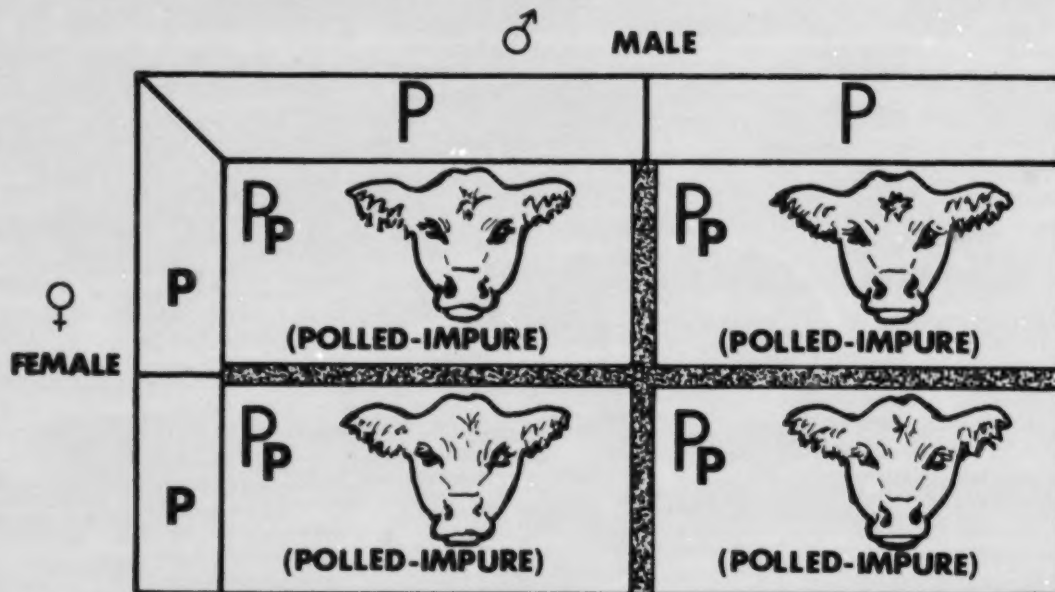


FIGURE 1.

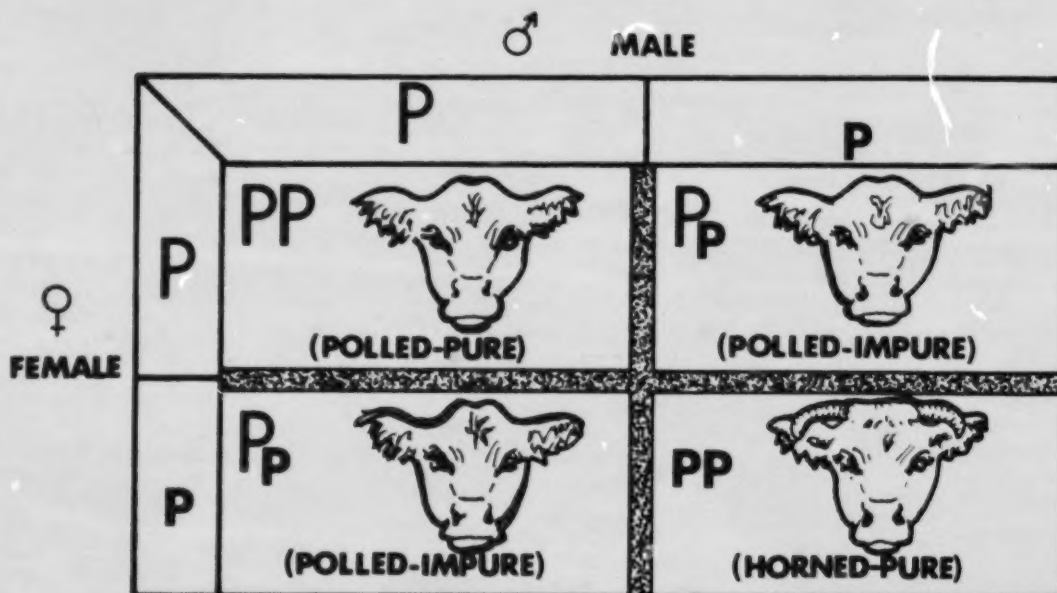


FIGURE 2.



COLOR DETERMINATION IN SHORTHORNS

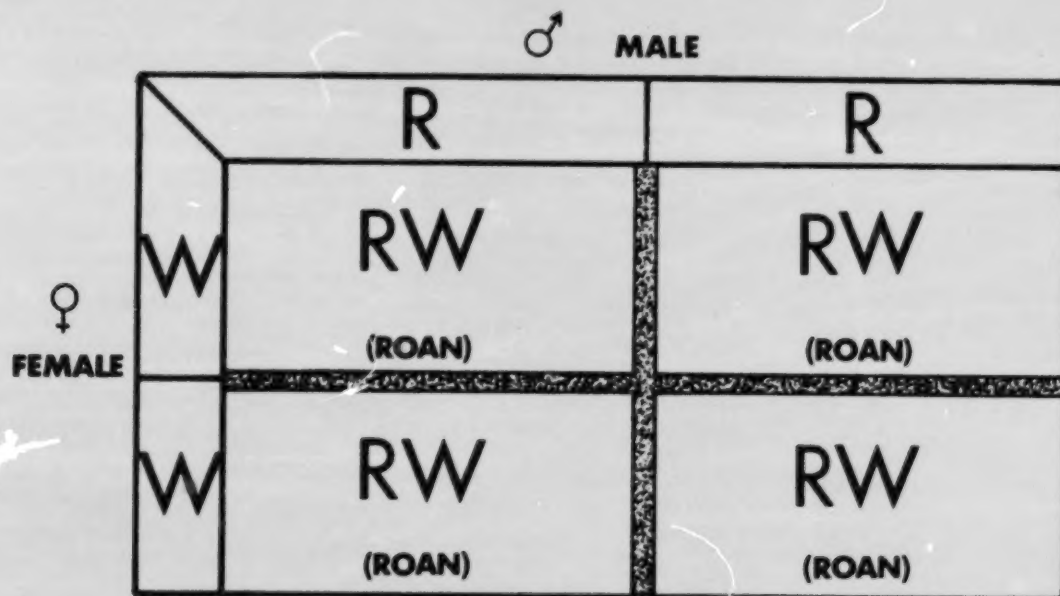


FIGURE 1.

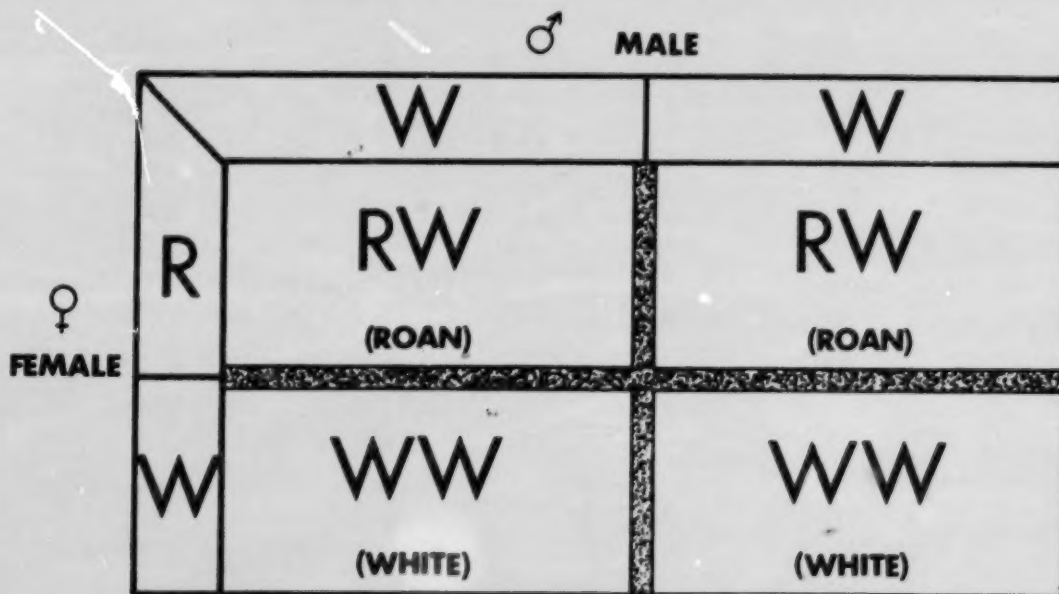
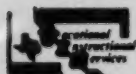


FIGURE 2.



A CROSS WITH TWO CHARACTERS

♂ MALE

♀ FEMALE

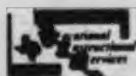
	PV	Pv	pV	pv
PV	PPVV (POLLED, WHITEFACED) ☆	PPVv (POLLED, WHITEFACED) ☆	PpVV (POLLED, WHITEFACED) ☆	PpVv (POLLED, WHITEFACED) ☆
Pv	PPVv (POLLED, WHITEFACED) ☆	PPvv (POLLED, COLOREDFACED) ★	PpVv (POLLED, WHITEFACED) ☆	Ppvv (POLLED, COLOREDFACED) ★
pV	PpVV (POLLED, WHITEFACED) ☆	PpVv (POLLED, WHITEFACED) ☆	ppVV (HORNED, WHITEFACED) ☆	ppVv (HORNED, WHITEFACED) ☆
pv	PpVv (POLLED, WHITEFACED) ☆	Ppvv (POLLED, COLOREDFACED) ★	ppVv (HORNED, WHITEFACED) ☆	ppvv (HORNED, COLOREDFACED) ●

☆ — 9 POLLED, WHITEFACED

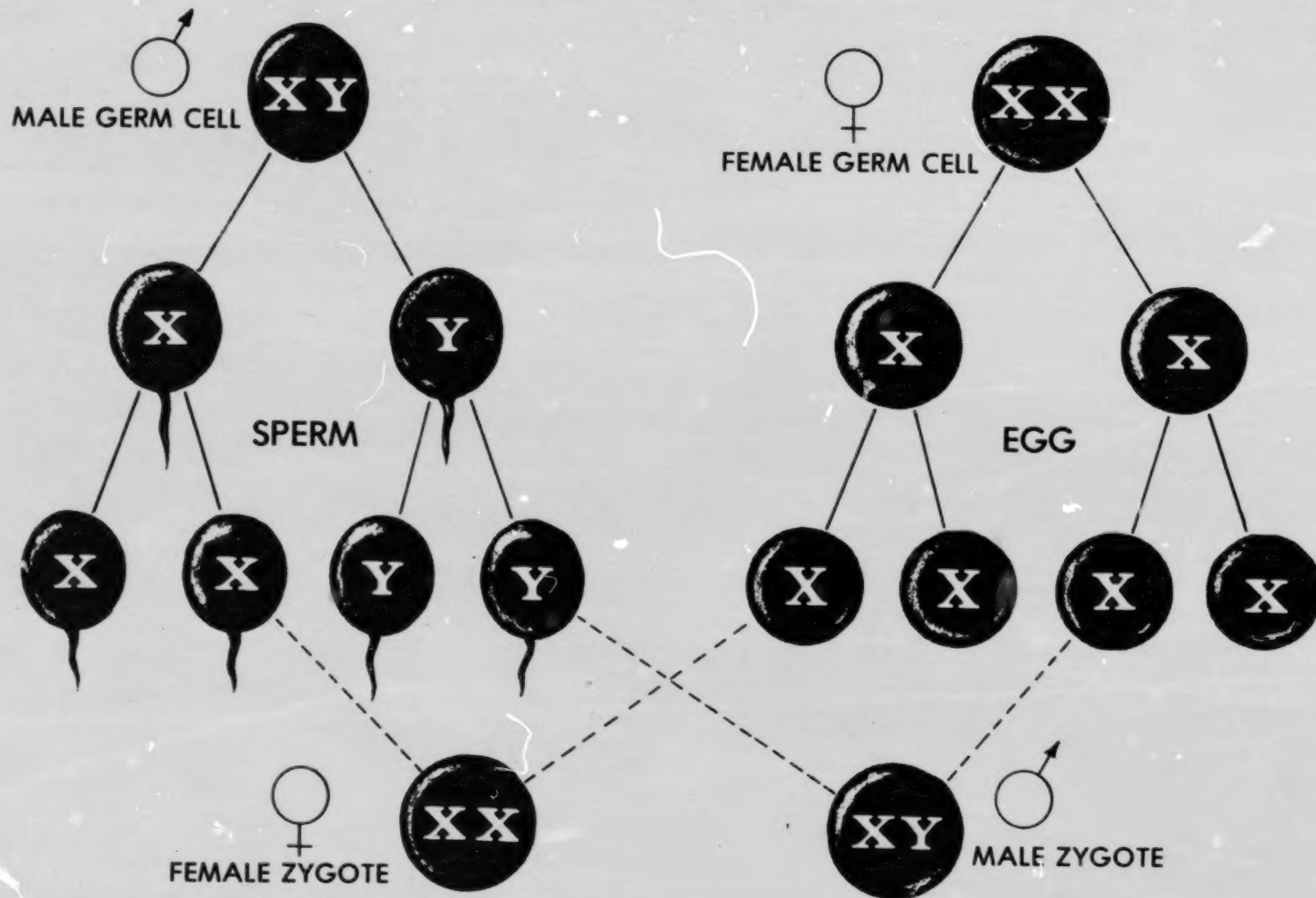
☆ — 3 HORNED, WHITEFACED

★ — 3 POLLED, COLOREDFACED

● — 1 HORNED, COLOREDFACED



SEX DETERMINATION IN ANIMALS



ANIMAL SCIENCE

Unit A: Animal Reproduction

Topic 2: Reproduction System

Note: All terms underlined are included in the "Glossary of Terms."

1. Introduction to Animal Science

The term "reproduction" means the production of young animals to continue the species. Reproduction takes place after mating between the male and the female. During copulation, the male sperm cell is introduced into the female reproductive tract. The sperm then unites with the female egg cell. The union of the sperm and egg takes place in the female uterus where the new offspring (embryo, the fetus) is protected and nourished until parturition.

Transparency No. 1

2. Anatomy and Functions of Male Reproductive System

Scrotum - Contains the testes. Helps maintain the temperature of the testes at about 5° below body heat in order to prevent sterility.

Testes - produces the male sperm cells and testosterone, the male sex hormone.

Epididymis - long, greatly coiled tube which connects to each testis. It functions in storage, maturation, and transportation of sperm cells.

Vas Deferens - (sperm duct) - elongated tube which connects the epididymis with the urethra. Its function is transportation of sperm cells to the urethra.

Spermatic Cord - consists of vas deferens, smooth muscle, blood vessels and nerves. It is enclosed in a protective, fibrous sheath.

Seminal vesicles - paired accessory glands which secrete seminal fluid into the urethra at the colliculus seminalis. The fluid functions in protection and as a transportation medium for the sperm.

Prostate Gland - found near the urethra and the bladder. It produces a fluid which is mixed with the seminal fluid.

Cowper's Gland - secretes a fluid similar to seminal fluid. It is secreted before ejaculation, and its purpose is to neutralize and cleanse the urethra.

Urethra - a tube extending from the bladder to the end of the penis. It functions as the transportation route for holding the semen and urine.

Semen - term given to the sperm plus the added accessory fluids (seminal and prostate fluids).

Penis - External organ which deposits sperm cells within the female reproductive tract. In animals with a fibro-elastic penis, a signoid flexure allows the penis to be extended for copulation. Animals with a vascular penis have no such structure. The retractor penis muscle returns the penis into the sheath after mating.

Transparency No. 2

3. Anatomy and Function of the Female Reproductive System

Ovaries - two organs near the posterior end of the reproductive tract. The ovaries contain many follicles in which eggs are produced. They secrete the female sex hormones, estrogen and progesterone, and form the corpora lutea (plural of corpus luteum).

Oviducts - (Fallopian Tubes) - two tubes that carry eggs from the ovaries to the horns of the uterus. They lie close, but are not attached, to the ovaries. The funnel shaped end of each oviduct near the ovary is called infundibulum.

Uterus (Womb) - an organ with two horns (branches) that are connected to the oviducts. Fetal development occurs here. The male semen is deposited either in the posterior uterus or mid-cervix regions.

Cervix - neck of the uterus. Separates the uterus from the vagina, acting as a valve.

Vagina - A passage way between the cervix and the vulva. The vagina expands to pass the fetus at birth.

Urethra - carries urine from bladder to vagina.

Clitoris - sensory and erectile organ of the female located just inside the vulva.

Vulva - the external opening of the reproductive and urinary tracts.

Transparency No. 3

4. Anatomy and Function of Male Reproductive System (Poultry)

Testes - produce sperm cells and seminal fluid.

Vas Deferens - connects testes with cloaca to carry seminal fluid and sperm cells.

Cloaca - connects the large intestine with the external opening (vent) of the alimentary canal. The vas deferens lead into the cloaca.

Papillae - organ located in the cloaca wall that introduces sperm cells into the oviduct.

5. Anatomy and Function of Female Reproductive System (Poultry)

Ovary - A chick has two ovaries and two oviducts but the right ovary and oviduct degenerate. Only the left ovary and oviduct develop and function. The ovary contains a large number of ova which develop into egg yolks.

Oviducts - carries the eggs through the reproduction tract. The ovary has five distinct parts:

1. The funnel of the oviduct receives the yolk from the ovary and stores the sperm cells.
2. The magnum secretes the thick white of the egg. The yolk remains here about three hours.
3. The isthmus receives the yolk and thick white and houses the egg about 1 1/4 hours while two shell membranes are added.
4. In the uterus, the thin white and the shell are added. The egg usually remains here approximately twenty hours.
5. The vagina receives the completed egg for a short time before it is laid, large end first.

Transparency No. 4

6. First Step In the Reproductive Process

The reproductive process begins with the heat period or estrus (time when the female will accept the male). The estrus cycle includes all of the events related to heat period in the non-pregnant female. The heat period is started by a ripe follicle, containing an egg, secreting the estrogenic hormone responsible for symptoms of heat.

In contrast, the ovary of a cow not in heat will have a corpus luteum (glandular structure) formed as soon as a ripened follicle ruptures and releases the egg. The corpus luteum secretes the hormone, progesterone, which maintains pregnancy.

7. The Process of Ovulation and When It Occurs

A ripened follicle ruptures, discharging an egg, near the end of heat or after the heat period. The egg drops into one of the oviducts where it may be fertilized if a viable sperm is present.

The corpus luteum appears soon after ovulation and secretes the hormone progesterone. This (1) causes the uterus to implant and nourish the embryo, (2) prevents other eggs from maturing, (3) maintains pregnant condition, and (4) assists in the development of the mammary glands.

If the egg is not united with a sperm, the corpus luteum atrophies, allowing another follicle to ripen and another heat period to occur.

If more than one egg is released and fertilized, multiple births occur. Animals originating in this manner are fraternally related (fraternal twins, etc.) and are no more alike than brothers and sisters from separate births. The occasional

division of a single egg fertilized by a single sperm results in identical animals (identical twins).

Ovulation occurs at different times during and even after the heat period for different classes of livestock. This becomes especially important if the animal is bred by artificial insemination, and in determining breeding times for the hand mating breeding system. For example, cows should be bred toward the end of heat, or shortly after. Ewes and goats are to be bred near the middle of the heat period, and sows should be bred on the second day of heat. Mares are normally bred on the second day of heat, and every other day thereafter throughout the heat period, because ovulation may occur at any time. The sperm will remain alive and viable for at least 24 hours within the female's reproduction tract.

Transparency No. 5

8. The Process of Fertilization; How and Where It Is Accomplished

Fertilization is the union of the sperm and the egg. In the process of natural mating or artificial insemination, the semen containing the sperm is deposited within the vagina of the female. The sperm cells ascend the reproductive tract through the cervix, uterus and into the oviducts. If the sperm cells are deposited at the proper time in relation to ovulation, a sperm will unite with an egg in the upper part of the oviduct. (In cattle, sperm live only 24 to 30 hours in the female reproductive tract and the unfertilized egg will live approximately 12 hours.)

The fertilized egg passes down the oviduct into the uterus. The embryo becomes attached to the mucous membrane of the uterus when it receives nourishment and is protected until fully developed. If no sperm unites with the egg, the female does not conceive, the egg cells are absorbed by the body, and the period recurs.

Transparency No. 6

9. Fetus Position During Gestation

The illustration at the left of the transparency indicates the normal position of fetus during gestation. The rear of the fetus is toward the rear of the cow and the legs of the fetus are folded underneath its body. The back of the fetus is toward the back of the mother. The position of the fetus will shift and change throughout pregnancy.

The illustration on the right shows the beginning stage of parturition. Following the first labor pains, the first water bag appears, increases in size, and ruptures from the weight of the contents. The second water bag (amniotic bladder) soon follows with the fetus. As the second water bag ruptures, the labor pains become more intense and presentation soon follows. Normally, the front feet will appear first, followed by the nose which is resting on the front legs. After the head, the shoulders, middle, hips, rear legs and feet appear.

10. Reproduction In Poultry; How Poultry Differs from Livestock

Sperm are introduced into the oviduct in the cloacal wall of the female by the papillae in the wall of the male. The sperm move up the oviduct to the funnel of the oviduct where fertilization takes place. It is possible for fertile eggs to be produced within 24 hours after mating. Sperm cells will remain in the oviduct for 2 to 3 weeks, retaining their full viability for about 6 days. The fertilizing ability of sperm cells decreases to approximately 50% on the 10th day, and to approximately 15% on the 19th day. Occasionally, eggs may be fertilized up to 26 days after a single insemination.

As an egg yolk is released from the ovary of the hen, it falls into the funnel of the oviduct where the female germ cell on the outer edge of the yolk is fertilized. The fertilized yolk then moves through the reproductive tract, acquiring the thick white, the shell membranes, the thin white, and the shell.

With the proper temperature and humidity after the egg is laid, the embryo continues to develop. The embryo is nourished by the egg contents which are completely consumed at the end of the 21 day incubation period.

11. Reproductive Failures in Livestock

Sterility, either permanent or temporary, may be caused by a number of reasons. Livestock reproduction failures may be due to a particular disease or a specific defect. Occasionally, a series of minor disturbances may halt reproduction.

Some of the more common reasons for reproductive failure are:

Anatomic Defects - the most common male defect is the retention of the testes in the abdominal cavity, rather than having them descend into the scrotum prior to birth, as is normally done. This condition is known as cryptorchid, and results in a sterile male. If only one testis is retained, the animal is said to be monorchid, but is not sterile. However, his sperm production is reduced. These are inherited traits, and animals showing this tendency should be avoided in the breeding program. Another common male defect is the scrotal hernia; also lack of exercise, malformed penis, and periods of high temperature may cause sterility.

The best-known female abnormality is that of the freemartin, the sterile female born with a twin brother. Only about 10% of these freemartins are normal animals. Some other defects are: absence of ovaries or uterine horns, closure of cervix or other tubes.

Mechanical Injury of Male or Female Genital Organs

Injury to genital organs may be caused by any number of means, principally by improper handling and fighting among animals. Diseases of reproduction tracts also are the causes of numerous calf losses, primarily through abortion at various stages of pregnancy. Four of the more common diseases are:

- (1) Brucellosis
- (2) Vibriosis
- (3) Trichomoniosis
- (4) Leptospirosis

Nutritional deficiencies - Proper amounts of vitamins and minerals are essential to efficient reproduction, as well as to good general health and optimum daily gain. The following vitamins and minerals are known to affect reproduction:

- | | |
|----------------|------------|
| (1) Vitamin A | (5) Cobalt |
| (2) Vitamin E | (6) Iodine |
| (3) Phosphorus | (7) Copper |
| (4) Calcium | (8) Iron |

Endocrine Disturbances - Some of the female reproductive disturbances are glandular in nature. The more common ones are: undeveloped reproductive tracts, irregular heat periods, sexual infantilism, abnormal function of corpus luteum and cystic follicle. Males may also suffer from glandular disturbances. Some of these are: sexual infantilism, lack of sex drive (libido) caused by lack of testosterone production, excessive fat as well as lack of finish and malformed or small testes.

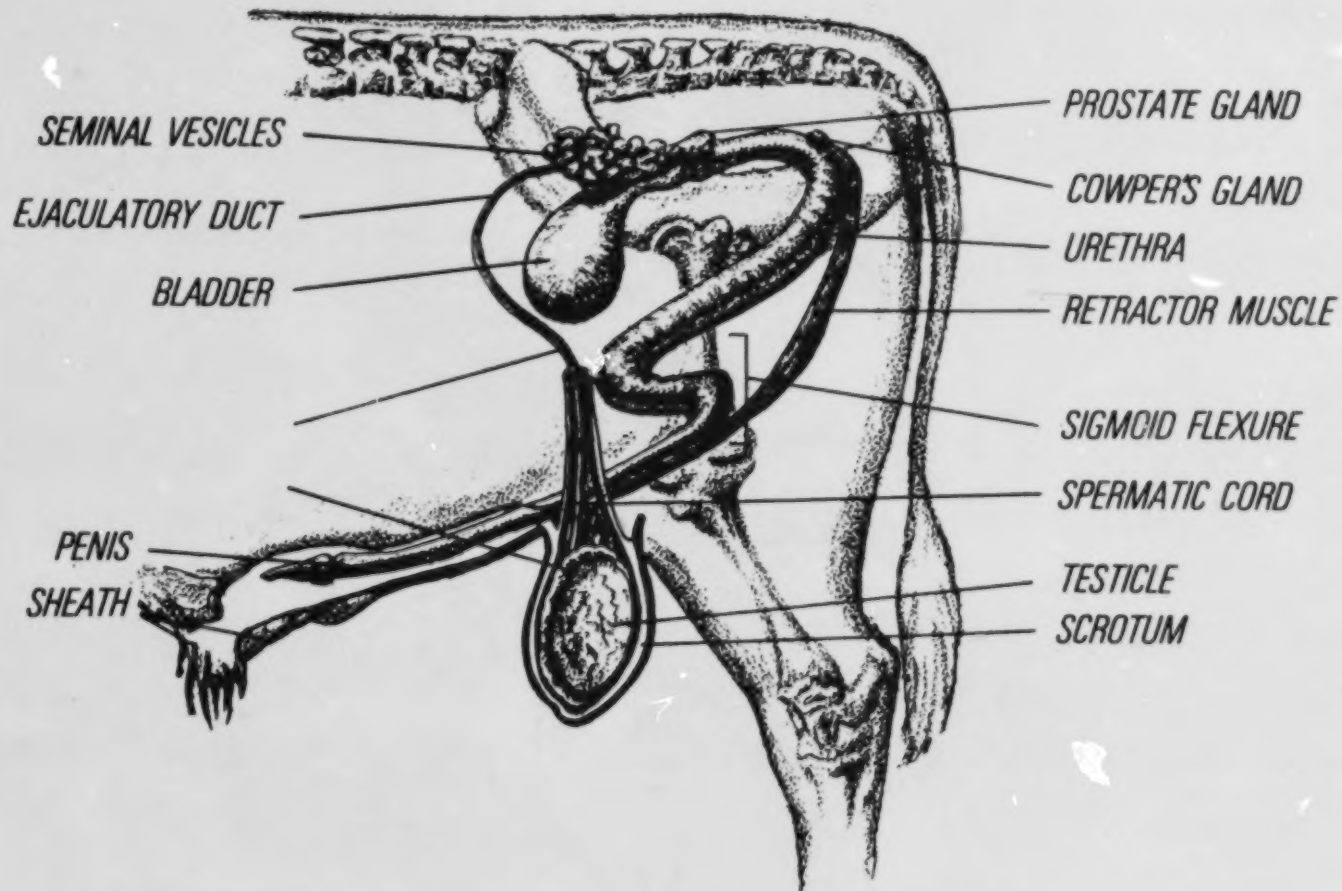
Genetic factors - some blood lines are recognized as having a high genetic factor for sterility, and should be avoided if possible also; inbreeding may cause decreased litter size and decreased fertility.

References:

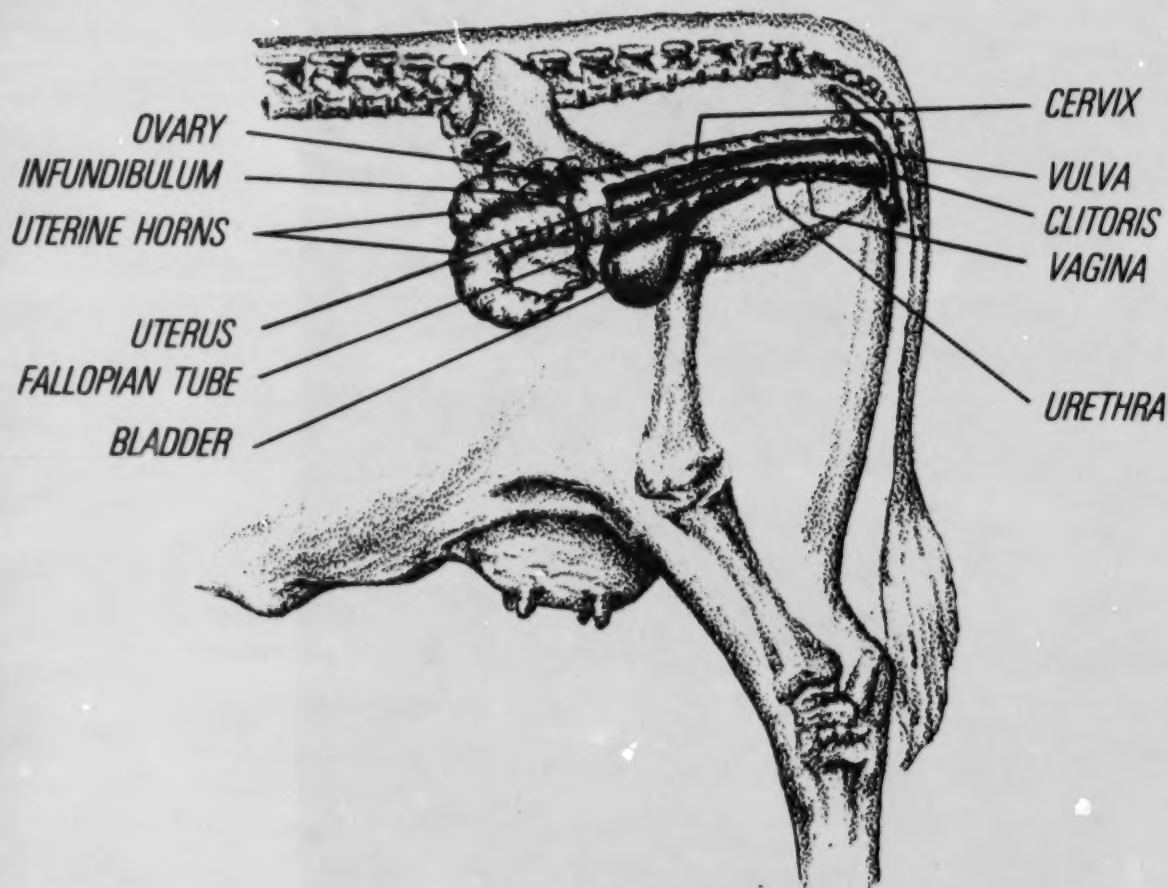
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MALE REPRODUCTIVE SYSTEM

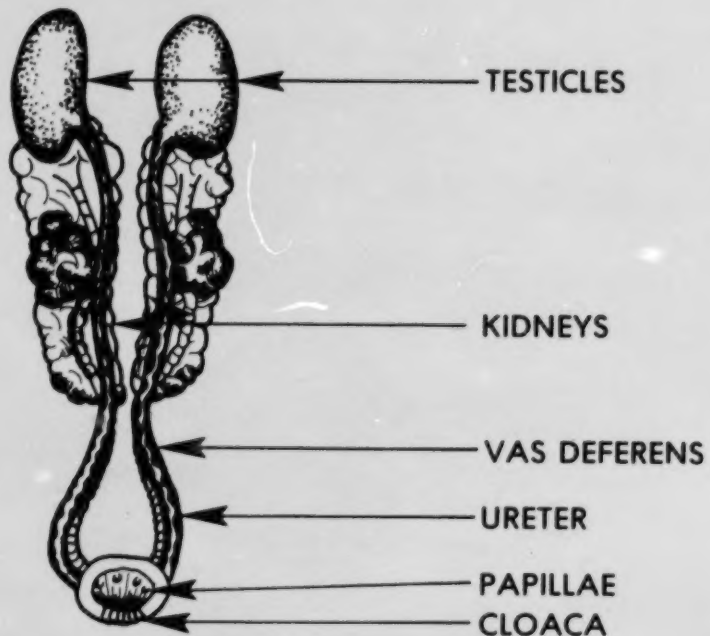


FEMALE REPRODUCTIVE SYSTEM

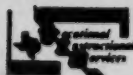
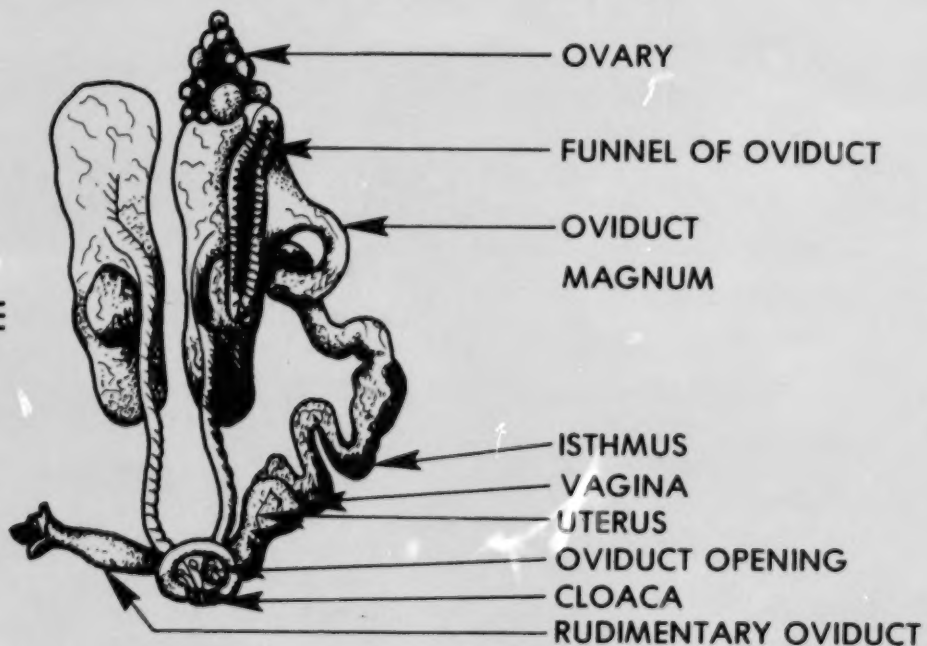


POULTRY REPRODUCTIVE TRACTS

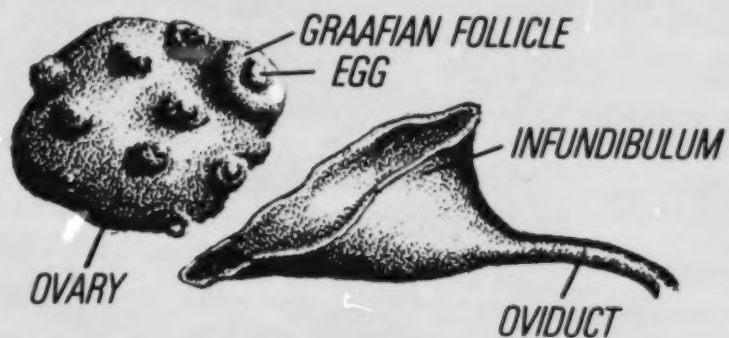
MALE



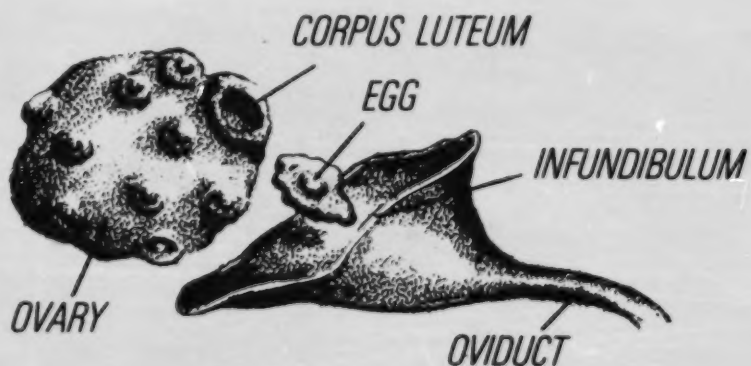
FEMALE



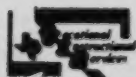
OVULATION



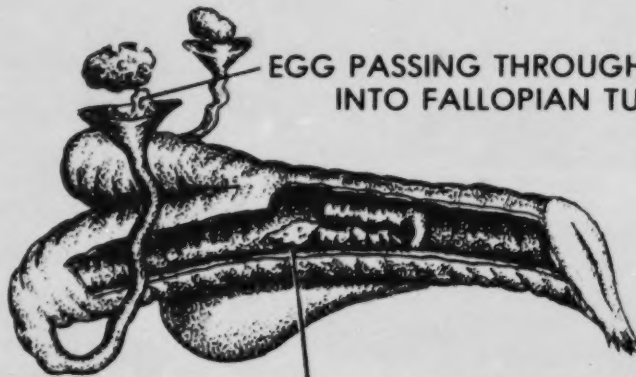
OVARY (during heat)



OVARY (after ovulation)

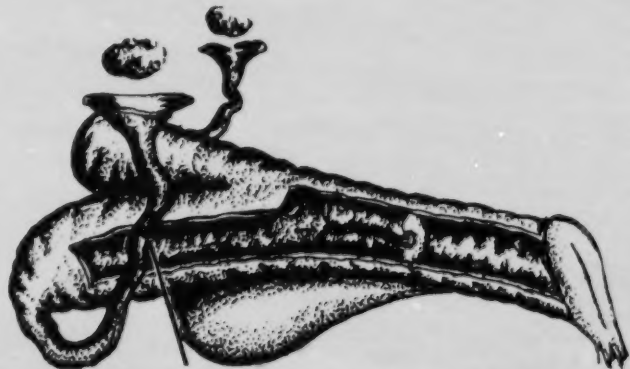


FERTILIZATION

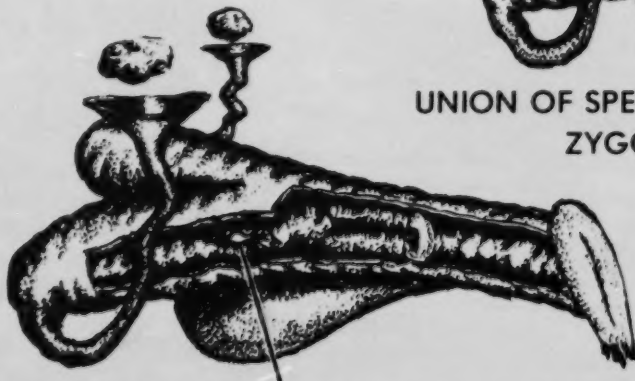


EGG PASSING THROUGH INFUNDIBULUM
INTO FALLOPIAN TUBE (oviduct)

SPERM DEPOSITED THROUGH CERVIX, MIGRATING
THROUGH UTERINE HORN INTO FALLOPIAN TUBE



UNION OF SPERM AND EGG AND MIGRATION OF
ZYGOTE (embryo) TO UTERUS



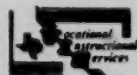
ATTACHMENT OF ZYGOTE TO WALL OF UTERINE HORN

POSITION OF FETUS DURING PREGNANCY



NORMAL POSITION OF FETUS
DURING GESTATION

POSITION OF FETUS DURING PARTURITION



V.A. III

II-A-2
No. 6

ANIMAL SCIENCE

Unit A: Animal Reproduction

Topic 3: Breeding Systems

Note: All terms underlined are included in the "Glossary of Terms."

1. Introduction

The information presented in this topic is on the breeding of cattle; however, it will in most instances apply to the breeding of other species of livestock. The terms used in describing the different methods of breeding are in general use but are not universally accepted by all authorities.

Due to a number of reasons, there is not any one system or method of breeding that can fit all livestock producers. All breeding systems have advantages as well as disadvantages, and mutation and chance are always factors that may influence the genetic makeup of a herd. The fact that selection is the single most important factor in the development of a breeding herd should be emphasized.

Breeding systems may be classified into two groups, (1) systems used by commercial producers and (2) systems used by purebred breeders. A fairly detailed discussion of the different matings used by breeders in both groups is given. In addition to the terms used in the discussion on breeding systems, commonly used terms by breeders for describing different matings are topcross, topincross, incross, and topcrossbred.

Several factors should be considered in determining the breeding system and matings to use:

1. Climatic conditions - Some breeds and crosses are more adaptable to certain weather conditions than others.
2. Markets - The location and type of market will influence the breeding system to use.
3. Knowledge of genetics - Some breeding systems are more complicated than others.
4. Size of operation - Crossbreeding, for example, requires several pastures.
5. Personal preference - This has a direct influence on the system selected. Some individuals prefer one system over another.

6. Available resources - Financing, equipment, labor, etc.
7. Goals of breeder.

2. Breeding Systems

Since commercial producers outnumber the purebred breeders, the systems used by them are discussed first. Grading up and crossbreeding are the two systems used by commercial producers.

Grading up

This is a system of mating purebred sires to commercial cows. It is used to improve quality, develop uniformity, and increase performance in the offsprings or progeny. Noticeable improvement can be expected through the fourth generation. After the fourth generation the herd is 94 percent purebred, or the breeding of the sire. Since the herd is almost purebred, progress will be much slower in succeeding generations.

Crossbreeding

In reality crossbreeding is the mating of two different purebreds; however, many commercial breeders refer to the progeny of grade animals showing a predominance of one breed mated to a purebred sire of another breed as crossbreds or F1s. This system might be referred to as indiscriminate crossbreeding. It may not give the results desired, as the progeny can be no better than the animals which produced them.

Many purebred breeders and others have criticized the crossbreeding of livestock. This has possibly been because they have not understood the benefits derived from this method of breeding. A successful crossbreeding program will include the use of purebred breeding stock.

The two principal reasons for crossbreeding are to combine the desirable characteristics of two or more purebreds to form a new breed or type which will have greater adaptability, and to produce hybrid vigor. Although new breeds have been developed by this method, few producers are interested in developing a new breed. The advantages of crossbreeding are as follows:

1. Weaknesses can be eliminated by breeding an animal strong in a character to animals that possess a weakness for the character;
2. It increases the average productivity of either parent;
3. Crossbreds are more fertile;
4. Crossbreds wean heavier offsprings; and
5. Crossbreds are more vigorous.

The importance of hybrid vigor (heterosis) has been recognized for a long time, but it is not fully understood. Heterosis may be described as the extra growth or vigor found in crosses between unrelated groups or inbred lines. The word heterosis was coined from the genetic term, "heterozygous," which means different inheritance.

The half inherited from one parent is different from the half inherited from the other parent. Genes are responsible for the passage of the hereditary material from parent to offspring and are carried in the egg of the female and the sperm of the male. Genes are present in every cell of the body in pairs. Each parent contributes one member of each pair. Research has revealed that if each of the two genes of a pair are different they interact, or work together, and help each other. A large number of the gene pairs are unlike in a hybrid.

The degree of heterosis is determined by the genetic make-up of the breeds crossed, and the wider the genetic background of the animals mated, the greater the amount of heterosis. Likewise, the closer the relationship of the animals mated, the greater the depression of heterosis in the offsprings. However, the genetic ability of animals is not determined by the breeds alone; it can be increased by crossing lines within a breed. A producer should remember that animals of inbred lines show a low degree of heterosis when mated to other breeds.

The level of heterosis varies from one trait to another, and those characteristics that are highly heritable and show a strong response to selection within a purebreed do not show a noticeable response in crossing. Low heritability traits respond poorly to purebreeding but have a high level of response to crossing. The livestock producer contemplating the crossbreeding of his livestock should be familiar with the heritability estimates of various traits.

Transparency No. 1

The level of heritability of traits shown in the above transparency are average heritability estimates and may vary some among beef animals.

A trait is highly heritable if it can be passed on to an offspring and is affected very little by the environment. A trait affected greatly by environment has low heritability. For example, the color of a black sheep is not affected by the environment; therefore, this trait is highly heritable. Rate of gain is a trait affected by the environment. Nutrition level, parasites, and other environmental factors can affect the rate of gain; therefore, this trait has only a medium level of heritability.

Transparency Nos. 2a and 2b

A comparison of several traits of cattle having different breeding is shown in

the above transparencies. Similar comparisons could be made of the traits of other classes of livestock.

Figure 1 compares the reproductive performance of Herefords, Brahmans, F1s and Herefords, F1s and Brahmans, and the second crosses and Santa Gertrudis. The offsprings from either the F1 cows bred to Herefords or Brahmans were superior to the purebreds and the Santa Gertrudis and second crosses.

Figure 2 shows the yields of milk and percent advantage of the crosses over the purebreds.

Figure 3 compares the percent lost from conception to birth and birth to weaning of the purebreds and different crosses. The F1 crossed on either the Herefords or Brahmans are also superior in these areas.

Transparency No. 3

The gains of the F1 calves were ten percent greater than the average of the two parent breeds. F2 calves produced by mating F1 to F1 decreased in hybrid vigor, as is indicated by the decrease in average daily gains.

In order to maintain the many advantages of crossbreeding, the livestock producer must follow a systematic breeding program. Two methods of mating that may be used in maintaining a successful crossbreeding program are the criss-crossing and rotational breeding. An illustration of these is shown in the following transparencies.

Transparency Nos. 4a and 4b

Several other methods of crossbreeding may be used by the producer. The method best suited for his operation should be selected.

Using the criss-cross method of crossbreeding, the breeder should divide his F1 females into two breeding herds. Bulls, breed A, are mated to herd one, F1 females; and Bulls, breed B, are mated to herd two, F1 females. Each herd provides replacements for the other. Some hybrid vigor is lost by using the backcross method described above.

The three-breed rotational plan for crossbreeding is possibly the best, since maximum vigor is maintained. The breeds used to develop the F1 should be distinctly different. This system can be used very successfully by breeders who maintain three or more herds. The example shown on the following page uses purebred sires and crossbred cows, while Transparency 4b is the same system using purebreds.

Herd 1

Bulls
Breed A

Cows			
Breed	A	B	C
	14%	29%	57%

Calves

Bulls -- Go to market

Heifers -- Replacements to herd 2, excess to market

Herd 2

Bulls
Breed B

Cows			
Breed	B	C	A
	14%	29%	57%

Calves

Bulls -- Go to market

Heifers -- Replacements for herd 3, excess to market

Herd 3

Bulls
Breed C

Cows			
Breed	C	A	B
	14%	29%	57%

Calves

Bulls -- Go to market

Heifers -- Replacements for herd 1, excess to market

Up until now, only the advantages of crossbreeding have been mentioned. Not every livestock producer should crossbreed. It is not a substitute for good management. If a producer does not have a problem in any of the areas of productions (growth rate, fertility, mothering ability, mortality, and general vigor) there is not any reason why he should crossbreed. Some disadvantages of crossbreeding are as follows:

1. Crossbred cattle are discounted on some markets; however, this prejudice is being overcome.
2. Several pastures are needed.
3. Replacement heifers are needed.
4. Selection is more difficult.

The systems used by purebred breeders are discussed below.

Purebred Breeding

This is the mating of animals of the same breed which are registered by a breed association, or are eligible for registry. A breed association is a group of breeders who have organized for the purpose of recording the lineage of their animals, keeping the breed pure, and promoting the breed or their

animals. A purebred animal's lineage can be traced to the original foundation animals of the breed which were first accepted for registry. In a few instances, breed associations have allowed the breeding of certain animals or breeds of animals outside of the registry to be bred to registered animals. The purpose is to infuse a characteristic(s) or trait(s) into the registered animals.

The word purebred is confusing to many inexperienced livestock producers. A purebred animal is not necessarily superior in any way. However, purebred animals should be superior in many aspects to grade animals.

A purebred breeder should have adequate capital and a knowledge of breeding, or be able to hire someone with the knowledge. All producers cannot be breeders of purebred livestock. Few purebred breeders receive a great return on their investment, but there will always be a need for purebred animals for crossbreeding and grading of commercial animals.

Inbreeding

This is a practice of breeding animals that have closely related ancestors on both sides and within the first four or five generations. Its purposes are to concentrate the inheritance and to fix desirable traits in a group of animals. Starting with a good group of animals, the breeder can make further improvements by inbreeding. Many outstanding herds have been developed by this system. Other ways in which inbreeding can be used to improve livestock are to (1) form families, (2) to produce seed stock, (3) to develop lines for crossing, and (4) to determine the genetic value of an individual. Disadvantages of inbreeding are decreased reproduction, vigor, survival rate, and growth rate.

Transparency No. 5

Matings and the amount of inbreeding for such matings are shown in the above transparency. Production efficiency of animals with 6.25 percent or less of inbreeding is usually not affected.

Linebreeding

This is a less intense form of inbreeding used to maintain and further improve by selection of high quality animals. Linebreeding does not offer the possibility of improvement nor regression that inbreeding does. Breeders who practice linebreeding usually mate animals that are both related to an outstanding animal, but they never breed animals that are closer than half brothers to half sisters. Some methods of linebreeding are as follows:

Selected bull X half sister

Son of bull above X daughters of dam above

Some very popular blood lines have been developed using the above methods of breeding. A breeder who is using linebreeding should start with good individuals and mate the best of recent ancestors. Linebreeding is successful only in herds that have a high degree of excellence and outstanding individuals as indicated by progeny tests.

Most linebreeding is practiced where the outstanding individual is not available for breeding purposes. If the individual is available, he should be bred to as many nonrelated animals as possible to spread his characteristics.

Linebreeding should be practiced only by those who recognize its potentialities and limitations and those who are knowledgeable in the principles of breeding.

References:

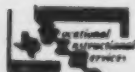
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AVERAGE HERITABILITY ESTIMATES FOR TRAITS IN BEEF CATTLE

AVERAGE PERCENT	TRAIT	LEVEL OF HERITABILITY
70	CARCASS RIB-EYE AREA	HIGH
60	TENDERNESS	
60	FINAL FEEDLOT WEIGHT	
60	EYE LID PIGMENTATION	
45	FEEDLOT GAIN	MEDIUM
40	EFFICIENCY OF GAIN	
40	BIRTH WEIGHT	
40	COW MATERNAL ABILITY	
35	CARCASS YIELD	
30	WEANING WEIGHT	
30	PASTURE GAIN	
30	CARCASS GRADE	LOW
30	CANCER EYE SUSCEPTIBILITY	
10	CALVING INTERVAL	



A COMPARISON OF SEVERAL TRAITS OF PUREBRED AND CROSSBRED CATTLE

FIGURE 1.	BREED OR CROSS OF DAM AND SIRE				
	HXH	BXB	FXH	FXB	SECONDCROSSXSG
% PREGNANT	89.3	78.6	91.7	95.7	71.4
% CALVED	82.1	71.4	86.4	91.3	71.4
% WEANED	78.6	42.9	70.8	86.9	71.4

FIGURE 2.

BREED OR CROSS OF COW	MILK YIELD, Lb.*	PERCENT ADVANTAGE OVER			
		H	B	H&B	SECONDCROSS
HEREFORD	7.4				
BRAHMAN	7.6				
AVE. OF H&B	7.5				
SECONDCROSS ($\frac{1}{2}$ A $\times$ $\frac{1}{4}$ B $\times$ $\frac{1}{4}$ H)	12.8	73	68	71	
F ₁ ($\frac{1}{2}$ B $\times$ $\frac{1}{2}$ H)	13.4	81	76	79	5
AVERAGE FOR CROSSES	13.1			75	

*Uncorrected for age of cow.

H - HEREFORD

A - ANGUS

B - BRAHMAN

SG - SANTA GERTRUDIS

A COMPARISON OF TRAITS OF PUREBRED AND CROSSBRED CATTLE

FIGURE 3.

MATING INVOLVED SIRE×DAM	PERCENT LOST		
	CONCEPTION TO BIRTH*	BIRTH TO WEANING**	TOTAL
B×B	3.0	20.5	23.5
H×H	2.1	2.2	4.3
B×H	0.0	4.0	4.0
H×B	0.0	4.7	4.7
B×(½B×½H)	0.0	0.0	0.0
H×(½B×½H)	0.0	0.0	0.0
A×(½B×½H)	0.9	0.9	1.8
A×(½A×¼B×¼H)	0.0	0.0	0.0

*=Calves lost as percent of cows pregnant

**=Calves lost as percent of cows that calved

H - HEREFORD

A - ANGUS

B - BRAHMAN

FEEDLOT RESEARCH OF PUREBREDS AND CROSSBREDS

FEEDLOT GAIN - 140 DAY TEST

BREEDING OF			AVE. DAILY GAIN, Lb.	ADVANTAGE FOR CROSSBREDS
SIRE	DAM	CALVES		
H	H	H	2.36	(2.20 BASEPOINT)
B	B	B	2.04	
H	B	F ₁	2.43	10%
B	H	F ₁	2.44	10%
F ₁	F ₁	F ₂	2.16	3% LOSS

H - HEREFORD

B - BRAHMAN

F₁ - (½H×½B)

CRISS CROSS METHOD OF CROSSBREEDING



BREED A x BREED B



F1 ($\frac{1}{2}$ A $\frac{1}{2}$ B) x BREED A



F1 ($\frac{1}{2}$ A $\frac{1}{2}$ B) x BREED B

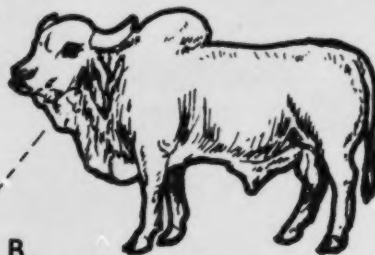


F2 ($\frac{1}{4}$ A $\frac{3}{4}$ B) x BREED A

F2 ($\frac{3}{4}$ A $\frac{1}{4}$ B) x BREED B

CROSSBREEDING

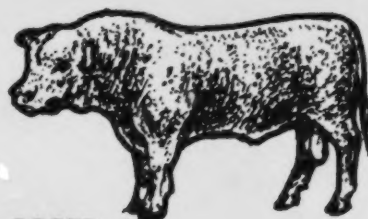
(THREE BREED ROTATIONAL CROSS METHOD)



BREED A x BREED B



F1 ($\frac{1}{2}$ A $\frac{1}{2}$ B) x BREED C



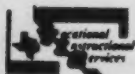
F2 ($\frac{1}{2}$ C $\frac{1}{4}$ A $\frac{1}{4}$ B) x BREED A



3RD CROSS (62.5% A 25% C 12.5% B) x BREED B

AMOUNT OF INBREEDING FROM VARIOUS MATINGS

MATING	OFFSPRING
brother x sister parent x offspring	25% inbred
$\frac{1}{2}$ brother x sister uncle x niece nephew x aunt	12.5% inbred
$\frac{1}{2}$ uncle x niece nephew x $\frac{1}{2}$ aunt	6.25% inbred
cousin x cousin	3.125% inbred



ANIMAL SCIENCE

Unit A: Animal Reproduction

Topic 4: Methods of Breeding

Note: All terms underlined are included in the "Glossary of Terms."

1. Selecting a Breeding Season

The selecting of a breeding season and the related calving season have a tremendous effect on the success of a livestock enterprise. Offsprings of about the same weight and age are easier to handle, will attract more buyer interest, and usually command a better price.

The desired season of birth of the offsprings will influence the breeding season selected. Producers normally prefer either spring or fall for the birth of offsprings. Each season has advantages and disadvantages.

Transparency No. 1

Advantages of Spring Births:

1. Less housing is required;
2. More economical to feed dry animals during winter;
3. Dams have access to pasture during period of greatest need;
4. Labor costs are reduced because grazing is available; and
5. Offsprings can be sold or put on feed in fall.

Transparency No. 2

Advantages of Fall Births:

1. Offsprings are weaned at a time when feeder prices are more favorable;
2. Less heat and insects; and
3. Labor supply is greater.

Transparency No. 3

Several factors in addition to the above should be considered in selecting a breeding season. The importance of the considerations listed below will vary from one specie of livestock to another.

1. Climatic conditions - These are particularly important since they influence the amount of equipment and housing needed.
2. Available labor - System of mating to use and time of year offsprings are born are affected.
3. Time animals are to be marketed - Price levels are often higher during specific periods in a year for certain classes of livestock.
4. Equipment and housing available - Some species of livestock will have to be born in a barn and provided heat during the winter in certain areas of the state.
5. Availability of grazing - If females and their offsprings are to be provided grazing, it is more dependable and easier to provide in the spring.
6. Livestock show dates - Classes for purebred breeding animals are based on ages. Animals having the maximum age for a class have an advantage.
7. Purpose for which livestock is produced - The birth of herd replacements determines the season in which they may be bred and the length of time it takes to bring them into production.

2. Age of Puberty for Different Classes of Livestock

Age of puberty and breeding age are two distinct areas. An animal reaching puberty is not necessarily capable of reproducing. Animals should be allowed to mature and develop after reaching puberty. Season of birth, temperature, nutrition (growth), and heredity affect the age at which animals reach puberty. Recent research reveals that weight (body development) is more important than age in determining when animals will reach puberty.

Transparency No. 4

Breeding ages vary according to the development of the animals within a breed and among the breeds within a specie. The producer must determine the minimum breeding age of the particular specie to be bred. To reduce production expenses and for other reasons discussed later, it is often advantageous to breed at a relatively early age. It is sometimes an advantage, however, to delay breeding. Recommended breeding ages for some animal species are given in the following transparency.

Transparency No. 5

Helpers - The age to breed helpers may vary widely depending upon body growth and development. Generally, they should be bred at 15 to 20 months of age and weigh between 575 and 750 pounds, depending upon the breed. The following transparency is based on recent research conducted by Texas A&M University.

Transparency No. 6

Weights for Brahman and Santa Gertrudis are not shown because it has been determined that both weight and age influence puberty in these breeds.

Breeding heifers to calve as two-year olds offers a physiological advantage as well as increasing milk production. Early breeding will also increase the life-time production of helpers from 1 to 1.3 calves; that is, if the helper is rebred in her second breeding season. Supplemental feeding or providing good grazing will cause heifers to develop faster and breed earlier.

Gilts - Gilts must have a well-developed body in order to withstand lactation stresses. At 8 to 10 months of age, they are usually developed sufficiently for breeding. They should weigh 225 to 240 pounds.

Ewes - The first breeding season after they become yearlings is the best time to breed ewes. They should lamb as two-year olds. Some ewes are sufficiently developed to breed them to lamb at 12 to 14 months of age, but this practice is not recommended.

Does (Goats) - The same recommendation for ewes applies to does. Spanish does may be bred earlier, however, than Angora does.

Mares - The best practice is to breed mares to foal at four years of age. However, they can be bred in many instances much younger.

Breeding ages of males is not as important as for females. The major consideration is the number and quality of offsprings that the male can sire in a given season. Total number of services allowed a male will vary according to age, development, health, temperament, condition, breeding system used, and distribution of services.

When pasture mating is practiced, factors such as range carrying capacity, size of area, and herd size will influence the number of females serviced by one male. While the exact number of females that can be served by a male cannot accurately be predicted, the ratio of males to females does not vary significantly among the most successful producers. The mature bull can serve 25 to 50 cows under pasture matings and 40 to 50 cows if hand mating is used. One bull to about 25 cows is the standard ratio for range conditions. Maturity among different breeds varies, but bulls should be ready for service at 18 to 24 months of age. Smaller breeds usually are ready for service at an earlier age than larger breeds. They mature earlier because testosterone production in males causes the growth of the long bones of the body. Since the long bones are shorter in the smaller breeds, they mature earlier.

Rams may be placed into the breeding program at 12 to 20 months of age. Normally, a ram can breed 50 to 75 ewes if hand mated and 30 to 60 ewes under

pasture mating conditions. A ratio of one ram to 25 or 30 ewes is recommended for range conditions.

Boars may begin breeding at 8 to 9 months of age. At this time they should be capable of breeding 25 to 50 sows with hand matings and 35 to 40 sows in a pasture mating system. Mature boars (one year and older) are capable of breeding considerably more sows than are young boars.

Stallions vary a great deal in their breeding capacity with regard to age. Two-year old stallions may breed 10 to 15 mares; three-year olds 30 to 40 mares; four-year olds 40 to 60 mares; mature stallions 80 to 100 mares; and over 18 years of age 20 to 40 mares. Stallions should not be allowed to pasture mate because of the possibility of injury.

3. Breeding Defects

Lethal characters or genes are hereditary and are transmitted from the parents to the offsprings. They may cause physical abnormalities or death at or near birth, or the animals to be unprofitable. Animals inheriting these characters should be disposed of and not kept in the breeding herd. The defects listed below appear in different degrees of severity.

1. Crooked legs or neck
2. Cancer eye in cattle (partially inherited)
3. Twisted nose
4. Missing dewclaw
5. Tailless
6. Dwarfism
7. Brain hernia
8. Genital abnormalities
 - a. Scrotal hernia
 - b. Vaginal and uterine prolapse
 - c. Malformed penis
 - d. Incomplete descent of testes
9. Single toe or "mule foot"
10. Extra legs
11. Lineback in Hereford cattle
12. Horns, buttons, or scurs in polled cattle
13. Skin and hair color
14. Stiff-legged horses
15. Inverted nipples in swine
16. Hair swirls on swine
17. Undershot or overshot jaws in sheep

4. Systems of Matings

Transparency No. 7

Hand Mating - Purebred breeders use this system to control the matings. When a female comes into heat, she is brought to the male for service. This requires additional labor, as the females must be checked twice daily during the breeding season. Also, additional labor is required in bringing the females to the male. Advantages of this system are the male can service more females, controlled matings; and accurate records (breeding dates, etc.) are easier to keep.

Pasture Mating - This system allows the males to be with the females throughout the breeding season or throughout the year if desired. If uniformity in size and time of parturition are of importance, males must be limited to a breeding season rather than yearly. Nearly all commercial herds use this method. Records for registered herds are more difficult to keep when more than one male is used for pasture mating. Where exact records are desired, use the recommended number of females per male, and keep them in separate pastures. This system may be used for all species of livestock.

Corral Mating - This system is utilized mostly by horse breeders, and entails putting the mare and stallion together in a well-fenced corral. Both mare and stallion are returned to their pens after service.

Stud Mating - This method is similar to hand mating, and may also be used by poultry breeders. The male and female are allowed to breed individually in a pen or coop.

Flock Mating - A system used by poultry producers whereby an optimum number of females are penned with several males. It is similar to the pasture method used by many livestock producers.

Pen Mating - One male is penned with 8 to 20 hens. System is used primarily by poultry producers.

Artificial Insemination - The use of I. A. is increasing and is used extensively by dairy farmers and producers of turkey hatching eggs. It consists of depositing semen in the female reproductive tract by artificial means.

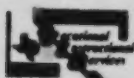
Transparency No. 8

References:

1. Ensminger, M. E., Animal Science, Fourth Edition, The Interstate Printers and Publishers, Danville, Illinois.
2. Ensminger, M. E., The Stockman's Handbook, The Interstate Printers and Publishers, Danville, Illinois.
3. "Ways to Increase Percent Calf Crop in Beef Cattle", B1107, Texas Agricultural Extension Service, Texas A&M University, College Station, Texas.

ADVANTAGES OF SPRING BIRTHS

- 1. LESS HOUSING REQUIRED**
- 2. MORE ECONOMICAL TO FEED DRY ANIMALS DURING WINTER**
- 3. DAMS HAVE ACCESS TO PASTURE DURING PERIOD OF GREATEST NEED**
- 4. LABOR COSTS ARE REDUCED BECAUSE GRAZING IS AVAILABLE**
- 5. OFFSPRINGS CAN BE SOLD OR PUT ON FEED IN FALL**



ADVANTAGES OF FALL BIRTHS

- 1. OFFSPRINGS ARE WEANED AT A TIME WHEN
FEEDER PRICES ARE MORE FAVORABLE**
- 2. LESS HEAT AND FEWER INSECTS**
- 3. A GREATER LABOR SUPPLY**

FACTORS TO CONSIDER IN THE SELECTION OF A BREEDING SEASON

- ☀ CLIMATIC CONDITIONS
- ☀ AVAILABLE LABOR
- ☀ TIME ANIMALS ARE MARKETING
- ☀ EQUIPMENT AND HOUSING AVAILABLE
- ☀ AVAILABILITY OF GRAZING
- ☀ LIVESTOCK SHOW DATES
- ☀ PURPOSE FOR WHICH LIVESTOCK IS PRODUCED

PUBERTY AGE FOR FARM ANIMALS

SPECIES

PUBERTY AGE (months)



SHEEP

5-8



SWINE

5-8



HORSES

12-18



CATTLE

8-14



POULTRY

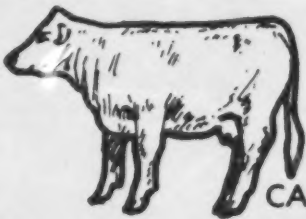
5½-6½



GOATS

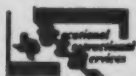
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RECOMMENDED BREEDING AGES FOR LIVESTOCK

SPECIES	AVERAGE AGE (months)	
	FEMALES	MALES
 CATTLE	15-20	18-24
 SWINE	8-10	8-9
 SHEEP	14-20	12-20
 GOATS	12-18	12-20
 HORSES	24-36	24-48

WEIGHTS AT WHICH BEEF HEIFERS REACH PUBERTY

BREED	WEIGHT (lbs.)	PERCENT REACHING PUBERTY
BRAHMAN CROSS (F ¹)	675	50
	725	70
	750	90
ANGUS	575	50
	625	70
	675	90
HEREFORD	600	50
	650	70
	700	90



METHODS OF MATING

*HAND MATING

* PASTURE MATING

* CORRAL MATING

* STUD MATING

* FLOCK MATING

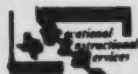
* PEN MATING

* ARTIFICIAL INSEMINATION



MATING GUIDE

AGE OF SIRE	HAND MATING (NO. OF FEMALES)	PASTURE MATING (NO. OF FEMALES)
BULL		
1-2 yrs.	10-12	8-10 (One bull for 25
2-3 yrs.	25-30	20-25 cows under range
3 yrs. or older	40-50	25-40 conditions)
BOAR		
8-12 months	24	12
1yr. or older	50	35-40
STALLION		
2-3 yrs.	10-15	Not recommended for most operations
3-4 yrs.	20-40	
4-5 yrs.	30-60	
5-18 yrs.	80-100	
RAM		
lamb	20-25	Not recommended
1 yr. or older	50-75	35-60
POULTRY		FLOCK MATING
Light breeds (Leghorns, etc.)	15-20	Males over 3 yrs.
General purpose (Wyandotte, etc.)	10-15	are not good
Heavy breeds (Dark Cornish, etc.)	8-12	breeders



ANIMAL SCIENCE

Unit A: Animal Reproduction

Topic 5: Breeding Livestock

Note: All terms underlined are included in the "Glossary of Terms."

1. Introduction

A number of elements influence reproduction in farm animals. The process of reproduction is a complicated one, especially in the female. Each element in the total process must be correctly related for the female to conceive.

The care and feeding of the young animals have a direct bearing on future reproduction. Puberty can be delayed, which in turn may cause a delay in a planned breeding season. Reproductive organs grow and develop as the animal increases in body size; therefore, proper care is essential. Any delay in growth will slow the onset of puberty and delay the breeding age of animals.

Not only is proper care and feeding necessary for the development of young animals, but it is a necessity for the maintenance of a high level of production in older animals.

2. Preparing Animals for Breeding

In order to be assured of a high conception rate, both males and females of most species of livestock must be managed (prepared) for breeding. The percent of females giving birth and weaning weight greatly affect the success of a livestock enterprise. In fact, the fastest means of increasing profits is to increase the number of females giving births. This single element has a tremendous effect on the cost per pound of the animals produced.

Ranchers should calculate the cost per pound of offspring produced to determine the efficiency of their operations and to determine the annual cost for each breeding female. This figure will vary from one ranch to another but is important to the producer. The following transparency illustrates the importance of a high calving rate in cattle and the cost based on weaning weight and percent of calf crop. Similar comparisons for other species of livestock could be made.

Transparency No. 1

Using a 90 percent calf crop and on average weaning weight of 495 pounds as an example, the producer's cost per pound of calf is 28.7 cents. A 70 percent calf crop and 350-pound calves increase the production cost to 40.7 cents per pound.

Weaning weight is influenced by (1) age at weaning, and (2) growth rate. The older offsprings usually weigh more at weaning time. Therefore, weaning weight is greatly influenced by when the offsprings were born, or how soon the females were bred during the breeding season. A delay in breeding reduces the weight of the offspring and average weaning weight, and increases the cost per pound of production. After considering the above, the conclusion can be drawn that reproductive performance of the females in a herd has the greatest influence on profits, losses, and success of the livestock enterprise.

The three factors affecting reproductive performance are: (1) Percent of breeding females coming into fertile heat; (2) Number of breeding females conceiving at each heat period; and (3) Death losses.

The proper preparing of animals for breeding is directly concerned with two of the above factors and will influence to some extent the third factor.

Cattle - To increase the average weaning weight, cows must be bred early in the season. In order for the cows to breed early in the season, they must calve 45 days before the start of the breeding season. Early bred cows will calve in a relatively short period of time, and the calves will have uniformity in age. For the cows in a herd to calve on schedule, they must breed within 82 days after they calve. This allows the normal gestation period of 283 days and keeps them calving within a 12-month period.

Elements influencing the estrus cycle are (1) age, (2) post-calving rest, (3) genetic capability, (4) nutrition, (5) semen fertility and breeding efficiency, and (6) disease. A producer should be concerned with all of these, but only the factors pertaining to preparation for breeding are discussed below.

Older cows come into heat quicker than young cows. First-calf heifers tend to have a lower pregnancy rate and require special preparation in order to get them to cycle. They also take longer to come into heat after calving. Several conditions are responsible for the delayed heat. One is first-calf heifers have to perform all the body functions of a mature cow, while at the same time attempting to grow. The problem is further compounded by the fact that the heifer is shedding incisor teeth, which limits her capacity for grazing. Milk production also affects the breeding performance of first-calf heifers.

A 90 percent conception rate can be maintained in first-calf heifers if they are handled properly. Since lactation is one of the conditions influencing the

rebreeding of heifers, limited suckling of the calf will help in maintaining a high conception rate. After the calves are 30 days old, they should be penned separately from the heifers and allowed to nurse only once daily. About 30 minutes are required for the calf to empty the heifer's udder of milk. Calves handled in this manner should be creep fed. Creep feeding keeps the calf growing and reduces lactation stress in the heifer.

An alternative to the above method is the early weaning of calves. The calves are weaned at three months of age. A disadvantage of this method is that a large number of the heifers will not breed until after the calves are weaned. These heifers will not breed within the 82 days required to keep them on schedule, and will not produce the second calf within a 12-month period. Calves weaned at this age will also require supplemental feeding and extra labor for handling them. Some breeders breed the heifers 20 to 30 days earlier than the rest of the cow herd in order that they can be rebred during the regular breeding season.

Post-calving rest influences the conception rate and the number of reproductive problems occurring during gestation and the following breeding season. Cows should not be bred until about 45 days after calving. About one-third of the cows with a shorter post-calving rest experience serious reproductive problems. However, a few cows in a herd will conceive shortly after calving and will have no problems.

Retained placenta is the most common problem of early breeding. The cow conceives, gives birth to a calf, but fails to properly release the placenta. If attention is not given to a cow with this problem, the uterus will become infected. This will reduce the conception rate, and the cow will calve 2 to 5 months late.

Genetic capability of the herd can be improved by basing the selection on the regularity of breeding. This will improve overall breeding efficiency. Genetic capability may be determined by examining the females for pregnancy about 45 days or more after the bulls are removed, or when calves are weaned. Non-pregnant females are removed from the herd and sold.

Nutrition is the most important of all environmental factors affecting reproduction. Most breeding failures and late calving can be related to a lack of adequate nutrition. Nutritional requirements for cows fluctuate considerably throughout the year.

Transparency No. 2

To nourish the unborn calf and get the cow off to a good start at calving, extra feed is usually required during the gestation period. After calving the feed

requirements are further increased. Milk production is the reason for the increased needs. If supplemental feed or good grazing is not provided, the cow will mobilize body fats to compensate for the deficiency and will suffer a weight loss. Too much of a weight loss will prevent the cow from cycling, and 13 to 15 months may lapse before calving.

A system of scoring cows on body condition has been developed by Texas A&M beef cattle specialists. The score indicates the nutritional level received by the cow and the amount of weight a thin cow needs to gain before calving in order to rebreed quickly. Overly fat cows can lose weight and still rebreed. The score is based on body condition only and does not reflect the merit of the cow.

Transparency Nos. 3, 4, & 5

The scores are based on a 1,000-pound cow. Gain or loss recommendations for smaller cows can be adjusted. For example, a cow with a condition score of 3 which needs to weigh 800 pounds at calving should gain 160 to 240 pounds to reach a body score of 5.

Cows should be separated by condition score 90 to 100 days before the start of calving season. Each group is fed according to their body condition.

It has often been said that "a bull is one-half of the cow herd". This is only partially correct, but a bull is far more important than any single cow in a herd, since he breeds 20 to 30 cows per season. Physical fitness and semen quality are both very important in the preparation of a bull for breeding. Such factors as general health, condition of feet and legs, age, teeth, and abnormalities of reproductive organs should be checked. Tender feet or lameness will prevent the bull from traveling to find cows in heat. The bull should be checked for reproductive abnormalities, such as adhesion of the penis, which prevents intromission with the female.

Another important consideration is the bull's "libido" or sex drive. This can be observed when the bull is placed with cows that are in heat. Some breeds, particularly Brahman or breeds with Brahman breeding, show a lack of interest in cows when humans are present. In such instances it will be necessary for the observer to remain out of sight.

Much of the information on preparing cattle for breeding applies to other species of livestock; therefore, the discussion of the preparation of other species for breeding will be much briefer.

Sheep - Four to eight weeks before the start of breeding, ewes should be flushed with good, lush pasture or extra concentrates. Flushing increases conception rates and influences twinning.

Heavy locks of wool, manure, and other foreign matter should be clipped from around the docks of ewes before the start of the breeding season. Also, while this area is being sheared, the ewes, particularly breeds having wool on their faces, should be sheared around the eyes. This operation is referred to as tagging because the wool having foreign materials imbedded in it is known as tags. Tags may prevent the ram from breeding the ewes and increase the possibility of the ewes having wool worms. Wool worms are attracted to the dock area because of the high moisture level in the wool after lanolin.

Shearing the rams before the breeding season will make them more active and aggressive, particularly in warm weather. If it is impractical to completely shear show or sales rams before the breeding season, the wool from their bellies (penis region) and neck should be sheared. If the hooves of the ram are long, they should be trimmed before turning the ram with the ewes.

In order to identify the bred ewes and the time of breeding, it is desirable to use a marking harness which is strapped to the ram's chest. Time of breeding may be reliably estimated by changing colors of the chalk in the marking harness periodically.

An acceptable alternative to the harness is the use of a thick paste smeared on the brisket area of the ram. This paste must be replenished at least every other day in order to insure clear marking of the ewe's rump. Tar or paint should never be used because it tends to stain and ruin the wool.

The color of the paste or crayon should be changed every estrus cycle (16 days) in order to find ewes that are coming back in heat and require re-breeding. Also, this is an ideal method of checking for non-breeding females and sterile males.

Thick lubricating oil and paint ~~tinting~~ colors make good paste. Yellow ochre, venetian red and lamp black make good tints to give the paste different colors. A common practice is to start with light colors and use progressively darker colors as the breeding season continues. If a large number of ewes fail to breed, the ram should be fertility tested or replaced with another ram. Temporary sterility may be brought about by lack of exercise or improper conditioning.

Swine - Sows should be flushed two to three weeks before breeding. This practice insures more profitable litters by: (1) causing more eggs to be released, and hence, larger litters, (2) the sows are more certain to conceive when bred, and (3) they tend to come into estrus more readily. Sows of normal weight should have their daily feed intake increased so that they gain about 1 to 1 1/2 pounds daily. Plenty of lush pasture and exercise should be made available for overweight sows, while the concentrate ratio is decreased. As always, provide plenty of clean water and minerals.

Boars should have free access to a well-fenced pasture of about 1/4 acre to provide exercise needed for sperm production. Overfat boars and very thin boars are usually poor breeders. They must be kept in a thrifty and vigorous condition in order to be virile, potent breeders.

Horses - Most authorities agree that mares are the most difficult of all livestock species to settle and to conceive. Plenty of exercise and adequate feed should be provided. Before breeding, mares should be checked for any signs of venereal disease, sickness, and other unsoundness. Also, be certain that the mare is in standing heat before attempting to breed her.

If possible, the mare should be taken to the stallion for service. The foal should be taken along if the mare is to be gone over five or six hours. If necessary, milk the mare by hand. Allow the mare to become quiet and settled before service. Overheated or excited mares should be cooled before breeding. Always be certain the mare is in heat and is ready for service. The mare may be teased by tying a stallion on the opposite side of a breeding partition. After teasing, clean the stallion's penis and sheath area with castile soap and warm water, and rinse with clean water. Cotton is preferable to a sponge for cleaning.

The mare's tail should be wrapped with a clean, inexpensive cloth or gauze in order to keep the stallion's penis clean, and to keep tail hair from interfering with breeding. Only the upper six to eight inches of the tail needs to be wrapped. Next, wash the external portion of the mare's reproduction system, similar to that of the stallion.

For greater control of the mare, hobbles and a twitch are used. The twitch may be removed while the mare is breeding. Allow the stallion to mount the mare only when he is ready for service. After mating, return the stallion to his stall or pen. Allow the mare to remain quiet for a short time after service. Any undue exertion or excitement of the mare should be avoided. After the mare is bred, she should receive the same ration as before breeding. If the mare does not conceive she will come back in heat in approximately 21 days and may be re-bred.

The stallion should have access to a roomy box stall which opens into a pasture paddock of about 2-3 acres in size. The stallion should be separated from the mares by a double horse-proof fence. Provide plenty of water and feed to meet the stallion's needs. He should be exercised each day.

3. Selecting a Bull for Breeding Heifers

Heifers experience more difficulty in calving than older cows. However, many of the calving problems in heifers can be eliminated by the proper selection of a bull for these matings. This does not mean the selection of any particular

beef breed, nor is it necessarily related to the size or age of the bull. A bull produces the same size calves at puberty as he produces at full maturity. The common belief that a small, young bull produces smaller calves is not based on facts. The visual appraisal of a bull's physical characteristics also is of little value in the selection process.

Several considerations should be made in the selection of a bull, but the principal factor is the birth weight of a bull's progeny. Since calves are sold by weight, another important consideration is the growth rate of the progeny.

Accurate information on birth weights and growth rate can be obtained only from breeders who conduct progeny tests. Progeny tests normally include percent easy births and calving ease in addition to other information. Percent easy births is the percentage of a bull's calves born without assistance and is expressed as a ratio. For example, a ratio of 100.4 means that the sire had a .4 higher percentage of easy births than other bulls of the same breed used in the comparison. Calving ease is a subjective rating of the relative ranking of a bull within his breed for the ease with which his calves are born. This is also expressed as a ratio.

Growth rate may be determined by observing the 205-day adjusted weight (weaning weight) of the progeny. This is the weight taken at weaning and adjusted within sex for age of calf and age of dam to a standard 205-day, mature cow basis. The greater the 205 adjusted weight, the better the growth rate.

Transparency No. 6

The data shown in the above transparency is hypothetical; however, it can be used to familiarize the student with progeny testing data.

Attention is directed to the different number of progeny from which the data were taken. The number of progeny for each item in the data varies, and this could be the case in actual tests. In addition to the above items, other data might be included in the breeder's records.

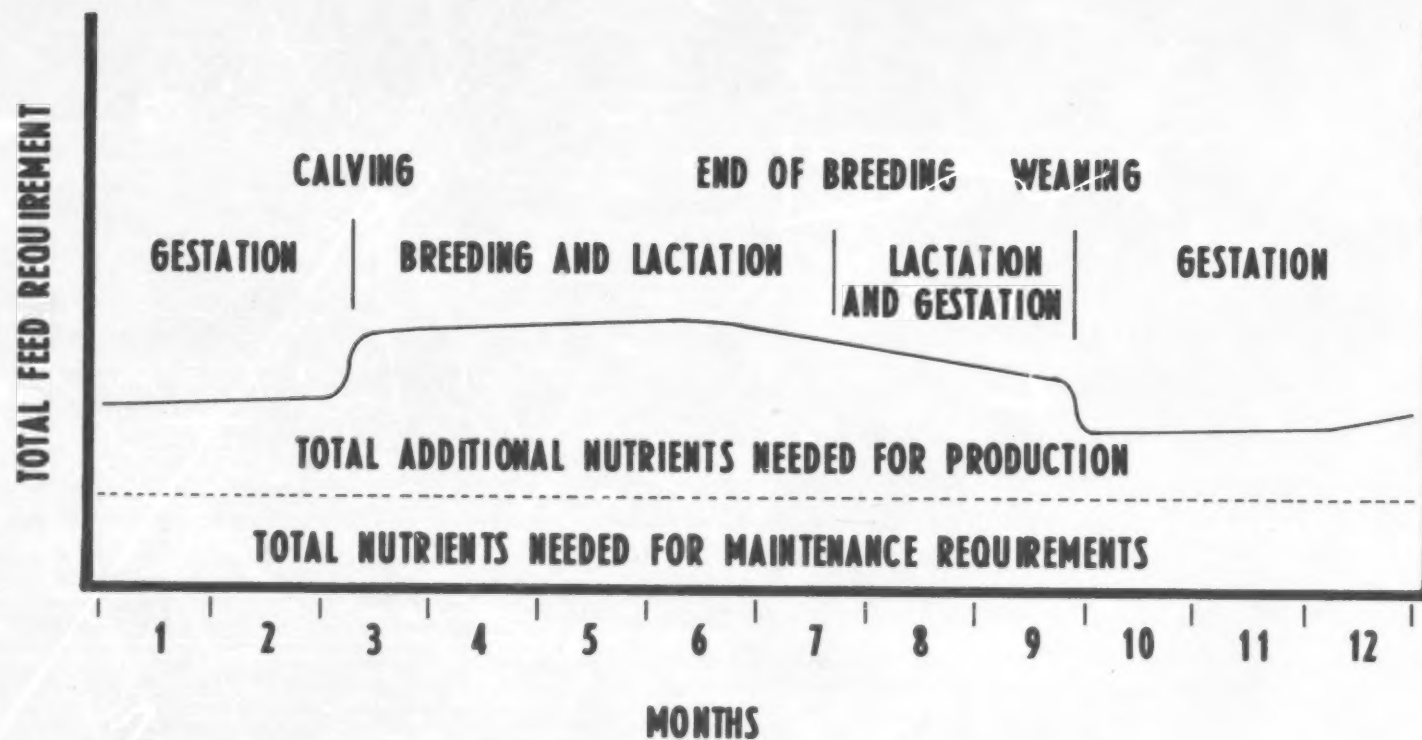
References:

1. Fowler, Stewart H., Beef Production in the South, The Interstate Printers and Publishers, Inc., Danville, Illinois.
2. Ensminger, M. E., Beef Cattle Science, The Interstate Printers and Publishers, Inc., Danville, Illinois.

PRODUCTION COST PER POUND
(based on an animal maintenance cost of \$225.00 per cow)

PERCENT CALF CROP		WEANING WEIGHT (lbs.) AND COST PER POUND				
100%	{	550	500	450	400	350
		40.9	45.	50.	56.3	64.3
90%	{	495	450	405	360	315
		45.5	50.	55.6	62.5	71.4
80%	{	440	400	360	320	280
		51.1	56.3	62.5	70.3	80.4
70%	{	385	350	315	280	245
		58.4	64.3	71.4	80.4	91.8

FEED REQUIREMENTS FOR A COW RAISING A CALF (12-month period)



BODY CONDITION SCORES

CONDITION SCORE 90-100 DAYS BEFORE CALVING		DESCRIPTION OF BODY CONDITION	DESIRED CONDITION AT CALVING	FEEDING RECOMMENDATIONS
TOO THIN	1	Poor- STARVING; BORDERING ON INHUMANE; SURVIVAL QUESTIONABLE DURING STRESS. NO PALATABLE FAT COVER OVER RIBS.	5	NEEDS TO GAIN MORE THAN 350 LBS. ECO- NOMICS QUESTIONABLE.
	2	Very thin POOR MILK PRODUCTION; CHANCES FOR REBREEDING SLIM TO NONE. SOME FAT PRESENT ALONG BACKBONE BUT NOT RIBS.	5	NEEDS TO GAIN 300 - 350 LBS. ECONOMICS QUES- TIONABLE.
	3	Thin LOWERED MILK PRODUCTION; POOR RE- PRODUCTION. FAT ALONG BACKBONE AND SLIGHT COVER OVER RIBS.	5	NEEDS TO GAIN 200 - 300 LBS.
BORDERLINE	4	Borderline REPRODUCTION BORDERING ON INADEQUATE SOME FAT COVER OVER RIBS	5	NEEDS TO GAIN 150 - 200 LBS.
	5	Moderate MINIMUM NECESSARY FOR EFFICIENT RE- BREEDING. GOOD MILK PRODUCTION. GOOD OVERALL APPEARANCE, SPONGY RIB FAT.	5-7	NEEDS TO GAIN WEIGHT OF FETUS (100 LBS.).
OPTIMUM	6	Moderate to good MILK PRODUCTION AND REBREEDING AC- CEPTABLE. SPONGY FAT OVER RIBS AND FAT NOTICEABLE AROUND TAILHEAD.	5-7	NEEDS TO GAIN WEIGHT OF FETUS (100 LBS.).
	7	Good FLESHY, MAXIMUM CONDITION NEEDED FOR EFFICIENT REPRODUCTION. SPONGY FAT OVER RIBS AND AROUND TAILHEAD.	5-7	NO WEIGHT GAIN NEEDED.
TOO FAT	8	Fat VERY FLESHY, UNNECESSARY. NO ADVAN- TAGE FOR REBREEDING, FAT DEPOSITS OVER RIBS, AROUND TAILHEAD, AND BELOW VULVA.	5-7	CAN PROBABLY LOSE 50 - 150 LBS.
	9	Extremely fat WASTY AND PATCHY; MAY HAVE CALVING PROBLEMS. COWS EXTREMELY OVER- CONDITIONED.	5-7	CAN PROBABLY LOSE 100 - 200 LBS.

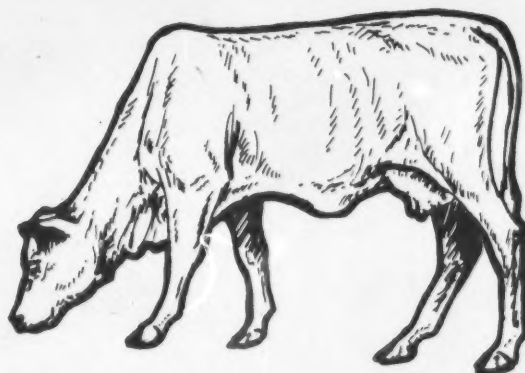
SCORES FOR EVALUATING BODY CONDITION

TOO THIN

POOR

VERY THIN

THIN



BORDERLINE

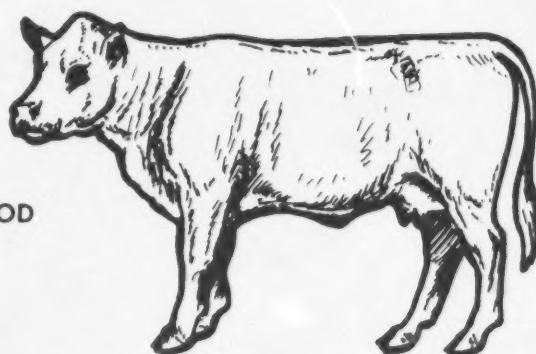
BORDERLINE

OPTIMUM

MODERATE

MODERATE TO GOOD

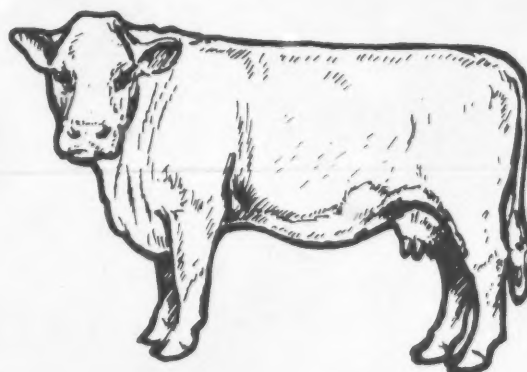
GOOD



TOO FAT

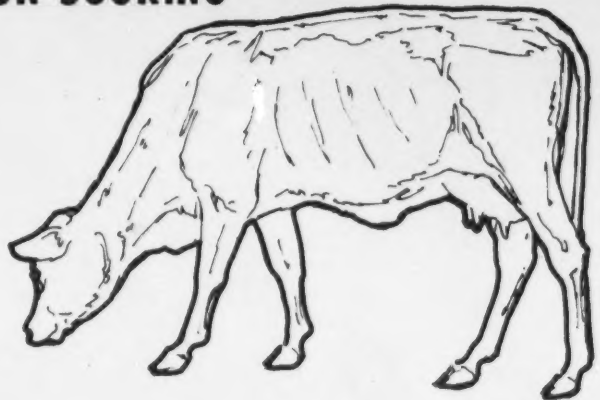
FAT

EXTREMELY FAT

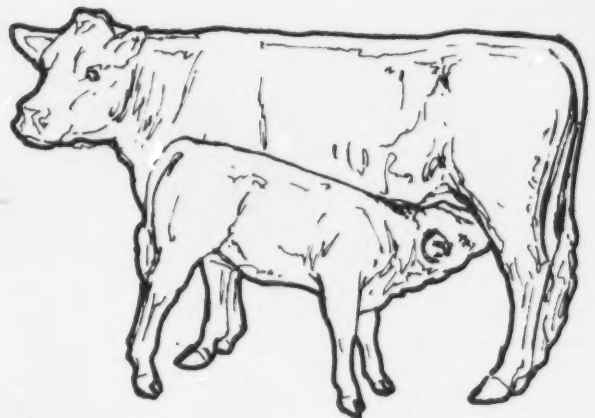


CONDITION SCORING

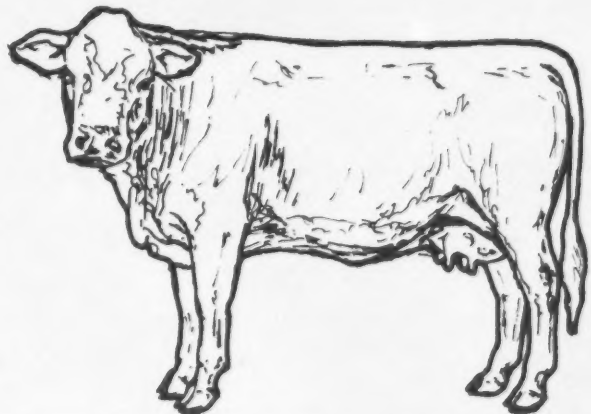
THIS COW, WITH A CONDITION SCORE OF 3, IS TOO THIN.



A SCORE OF 5 IS GIVEN TO THIS COW. SHE IS FAT ENOUGH FOR GOOD HEALTH BUT IS NOT CARRYING ANY EXTRA WEIGHT.



THIS COW HAS THE MAXIMUM CONDITION FOR EFFICIENT REPRODUCTIVE PERFORMANCE. SHE RECEIVES A SCORE OF 7.



PROGENY DATA

DATA	NUMBER OF PROGENY	PROGENY AVERAGE	RATIO
LENGTH OF GESTATION	85	283 days	—
BIRTH WEIGHT	66	76.9 lbs.	104.9
PER-CENT CALVING EASE	119	—	100.4
205 - DAY ADJUSTED WEIGHT	82	471	104.5

ANIMAL SCIENCE

Unit A: Animal Reproduction

Topic 6: Care at Parturition

Note: All terms underlined are included in the "Glossary of Terms."

1. Introduction to Parturition

The time approaching and during parturition is a critical stage in the production cycle of livestock. By keeping accurate breeding records, the producer will be prepared to render assistance to the animal at parturition. The record may be an individual breeding record or a record of when the male(s) was placed with and taken from the herd.

Some classes of animals require more assistance at parturition than others, and producers who plan to give assistance to animals should make preparations before parturition begins. Assistance given at the proper time will save many young animals and possibly the female from having a parturition problem.

Several items of equipment should be acquired by the producer prior to the parturition season.

Transparency No. 1

2. General Signs of Approaching Parturition

The exact date of parturition in animals is difficult to determine, but there are certain general signs of approaching parturition with which the livestock producer should become familiar. Some signs are more distinct in one kind of animal than in another. Several signs which indicate parturition is approaching are listed as follows:

Transparency No. 2

Distended Udder - A distended udder will become noticeable two to six weeks before parturition in cows and mares. The udders of sheep do not usually become distended until ten days to two weeks before parturition.

Muscle Shrinkage - As parturition time approaches in cattle and sheep, the muscles around the pin bones and tailhead shrink and fall away. The muscle parts at the top of the buttocks shrink and fall away about seven to ten days before a mare foals.

Vulva - The vulva of all livestock swell and become enlarged just prior (two to three days) to an animal's giving birth.

Wax on Ends of Teats - Wax forms on the ends of the teats of ewes and mares two to four days before parturition.

Restlessness and Nervousness - All livestock becomes restless and nervous just prior to parturition; the animal will usually separate from the rest of the herd before parturition.

Change in Contents of Udder - The contents of the udder of all livestock will change from a watery fluid to a heavy colostrum milk two to three days before the young animal is born. Sows will usually farrow within twenty-four hours after the milk develops in their nipples.

Many of the signs of approaching parturition mentioned above are evident in swine. Most swine producers keep accurate breeding records and place their swine in a farrowing facility a few days before they farrow.

3. Preparing Livestock for Parturition

As parturition approaches, the pregnant animal should be moved to the quarters where they will give birth to their young. This should be several days before parturition in order that they will become accustomed to the quarters. If the weather is warm and a clean pasture is available, this is an ideal place for most animals to give birth.

Preparations that should be made for parturition for several kinds of animals are explained as follows:

Cattle - Cattle have very few calving problems, and most cows are calved in pastures. During inclement weather, however, it may be necessary for the producer to provide calving stalls. The stalls should be clean, well-ventilated, and comfortable. Most producers place their pregnant animals in a small pasture during the period before calving so the animals can be observed closely. They ride through the pasture two or three times a day so that assistance can be given to any cow having trouble calving.

Swine - The farrowing house must be well-ventilated and should be thoroughly cleaned and disinfected before moving the sow into it. Heating equipment should be checked and placed in operating condition. The temperature should be maintained at 60° to 70°F. The farrowing pen should be bedded with a light covering of bedding materials. Ground corn cob, peanut hulls, shredded fodder, wood shavings, and chopped hay may be used as bedding.

Prior to moving the sow to the farrowing quarters, she should be washed with soap and warm water; special care should be taken to thoroughly wash her sides and underline. This will remove worm eggs and other parasites which may infect the pigs.

The sow should be isolated from the herd and placed in the farrowing stall four to five days before farrowing. The sow should be given exercise and a laxative feed while confined to these quarters.

Mares - If the ground is dry, a clean pasture or paddock is an ideal place for the mare to foal. If weather conditions do not permit pasture foaling, a roomy, clean box stall away from other animals should be provided. A lye solution, 8 ozs. of lye to 20 gallons of water, may be used to disinfect the stall, and a lye solution of 4 ozs. to 20 gallons of water is used to disinfect feeders and troughs. The stall should be bedded with absorbent bedding materials, and all obstructions that might cause injury to the mare or foal should be removed.

A few days before the mare foals, a light, laxative feed should replace from one-third to one-half of her grain ration. Wheat bran is a laxative feed which may be substituted for the grain.

Ewes - To prepare ewes for parturition, the producer should tag them four to six weeks before lambing. Tagging is the process of shearing the wool from around the ewe's eyes and face, teats, udder, rectum, and insides of the rear legs. This prevents the young lamb from nursing a tag and starving, keeps the area around the rectum and vulva free of dung and afterbirth, makes the lamb easier for the ewe to find, makes it easier for the ewe to eat, and reduces the chances of the ewe having wool worms.

The production method used by the producer will influence the method used to prepare ewes for parturition. An explanation is given of the several methods that may be used:

1. Pasture lambing - Several variations are used in lambing ewes in a pasture. One method is to allow the ewes to lamb in the pasture without assistance or any special care. Another method is to work the ewes through a cutting gate every two weeks and group the ewes that are going to lamb in a few days. These ewes are then grazed in a small lambing pasture, either permanent or temporary. The producer goes through the pasture several times a day to check the ewes. If a ewe has trouble lambing, the producer will assist her. After the lambs have been observed for five or six days, they are moved with a group of ewes and lambs requiring the same kind of care.
2. Combination Pasture and Shed - During the day the ewes graze in a pasture and are put under a shed at night. Ewes that lamb either place are separated

from the flock.

3. Lambing Pens - Ewes lamb in an individual pen, or several ewes are kept in a larger pen until they lamb. After the ewes lamb, they are placed with their lambs in an individual pen.

4. Caring For the Cow at Calving Time

Normally, the only time a cow would need special care at calving time would be in extremely cold weather. First calf heifers should be watched closely should they need assistance with calving.

Transparency No. 3

If presentation of calf appears to be normal, the attendant should stay out of sight of the animal. A cow will have a calf in a normal presentation in one to two hours. If the cow has labored for some time and is laboring less frequently, the attendant should give her some assistance.

It is difficult to determine exactly when to render assistance. In a normal presentation, mild infrequent labor pains start a few hours before actual parturition. After some time, a water bag appears outside the vulva. It increases in size until it ruptures from its own weight. A second water bag (amniotic bladder) follows the first one and appears with the fetus. After the second water bag ruptures, labor pains become more intense. Presentation normally occurs soon after the second water bag ruptures. If presentation is not shortly after the rupture of the second water bag, assistance should be given. Steps to follow in giving assistance are as follows: (1) Check fetus to determine if it is in a normal position; (2) Turn fetus to normal position if possible; (3) Place obstetrical chain or cotton rope around each leg just above pasterns. Make a half hitch just below the loop in the chain or rope on the legs of the fetus; and (4) Pull fetus outward and downward as the female strains. The proper procedure is to pull one leg then the other leg. If additional pressure is needed in order to move the fetus, the chains or ropes are attached to a calf puller.

Transparency Nos. 4a & 4b

The above transparencies show several abnormal presentations. These would apply to mares and ewes.

Picture No. 1 shows both front legs bent at the knees. The legs should be extended for normal presentation.

Picture No. 2 shows an anterior presentation with the head bent backwards. The head must be straight for normal presentation. This can sometimes be accomplished by slowly pushing the fetus back.

In picture No. 3 one leg is bent backwards at the knee. For normal presentation, the attendant should place a rope around the leg that is bent backwards, push the head up, and pull the leg forward.

In picture No. 4 the hind feet are in the pelvis. The fetus must be turned so that the head, forelegs, or hind legs can be started through the pelvis.

Picture No. 5 shows a buttock presentation. The fetus should be pushed forward and the hind legs brought into the genital passage for presentation.

Picture No. 6, is a back presentation. Delivery is usually normal in this presentation, but it may be necessary to assist the animal by applying traction.

When an attendant has had to assist an animal with presentation, he should wipe the mucus from the calf's nostrils; and it may be necessary to apply artificial respiration to get the young animal to start breathing. To prevent the possibility of a navel infection, the attendant should treat the young calf's navel cord with a two percent iodine solution.

Generally, the newly born calf will nurse within one-half to one hour. If the calf is weak, the attendant may have to assist the calf by holding it where it can nurse.

The cow should expel the afterbirth in three to six hours. If she has retained the afterbirth after twenty-four hours, it should be removed. A plastic glove is placed on the hand and arm and is lubricated with vaseline or linseed oil before inserting the hand and arm into the vagina to remove the afterbirth. An antiseptic should be placed in the uterus and the cow given an antibiotic.

5. Caring for the Sow at Farrowing Time

It has been estimated that thirty to thirty-five percent of all baby pigs are lost at birth. The number of pigs saved can be the difference between profit and loss.

Most sows do not need assistance at farrowing time; however, the attendant should be available should the sow need assistance and to take care of the pigs as they are born. The following care should be given the young pigs:

1. Wipe membrane from pigs with a clean, dry cloth;
2. Clip navel cords about 2 1/2 inches from the bellies of the pigs;
3. Swab navel cords with a two percent iodine solution;
4. Provide heat for pigs (90 to 95°F at floor level under heat lamp);
5. Inject pigs with iron (Preferred site for injection is under forearm or in neck. Give a second injection in 14 days);

6. Cut needle teeth. (There are eight sharp needle teeth, two on the upper and lower jaw on each side of the pigs mouth. Cutting these teeth will prevent the pigs from cutting each other and the udder of the sow. Care should be taken not to injure the pig's gums. Side-cutting pliers may be used to cut the needle teeth);
7. Provide plenty of fresh water for sows;
8. Eartnotch the pigs. (Purebred breeders and some commercial swine producers notch the ears of pigs at birth. This is used to identify the pigs so as to determine the productivity of the sow);
9. Equalize litter sizes by combining litters (Small weak pigs are placed with heavy milking sows, and large pigs are placed with sows giving less milk);
10. Cut the tails of pigs to one-half inch of body if pigs are to be finished in confinement;
11. Provide pigs with pig prestarter on fourth day (Small amounts of fresh starter should be made available daily);
12. Feed 20 percent starter ration until pigs weigh 10 pounds; and
13. Castrate pigs at two weeks of age.

6. Care for the Mare at Foaling Time

Usually mares do not experience difficulty at foaling time, but an attendant should be available to prevent injury to the mare, foal, or both. The attendant, however, should not be in sight. Some mares will postpone parturition as long as possible if the attendant is in sight.

Indications that a mare is going to foal are uneasiness, nervousness, lying down and getting up, bitings of the sides and flanks, sweating in the flanks, switching of tail, and frequent urination. A mare with a normal presentation will foal in fifteen to thirty minutes after these indications become evident. At the height of the labor pains, the mare usually will lie down; and it is in this position that the colt is usually born. Give the mare a reasonable length of time to foal; if she does not, assistance should be given. The attendant should follow procedures for good sanitation and be as quiet and gentle as possible.

The mare should expel the afterbirth within one to six hours after she has foaled. The attendant may wish to tie a part of the afterbirth to the mare's tail before she has expelled all of it. This will prevent her and the foal from stepping on it and possibly causing an inflammation of the uterus. If the afterbirth is retained longer than six hours, a veterinarian should be called. If lameness is evident in the mare, this is a sign of laminitis; and the mare will need treatment.

After the mare has foaled, a restricted amount of water should be made available to her periodically. The feed should be light and restricted on the first feeding after the mare has foaled.

If the mare foaled in conditions other than a clean pasture, the navel cord of the foal should be treated with a ten percent iodine solution to prevent joint-ill or navel-ill, a fatal disease in fifty percent of the cases. The iodine solution may be applied by filling a wide mouth jar, placing the foal's navel cord in the jar, and pressing the bottle against the foal's abdomen. If it is necessary to cut the foal's navel cord, it should be cut diagonally across the cord or scraped into with a knife. This prevents excessive bleeding.

The foal should be on its feet and attempting to nurse the mare within two hours after it is born. If it is weak or unable to nurse for some other reason, the attendant should assist it.

The foal should receive the colostrum milk of the mare, and if it is unable to nurse, the mare should be milked, and the milk fed to the foal. Since constipation can be fatal, the foal should have a bowel movement within twelve hours after it is born. If it appears sluggish and does not nurse, the foal should be given an enema of warm water with a little glycerin or warm soapy water. The foal should also be checked to see that it does not have diarrhea, which may be caused by the mare's milk or unsanitary conditions. If it is caused by milk, the feed given to the mare should be decreased.

7. Care of the Ewe at Lambing Time

Healthy, well-fed ewes seldom have trouble lambing. The system used to lamb will determine whether the producer can give the ewe assistance should she have trouble lambing. Ewes that are lambed in a small pasture, pens, or under a shed should be observed from time to time but not bothered unless they need assistance.

If assistance is needed, the attendant should disinfect his hand and arm and apply a coating of vaseline on his hand and forearm. He should first determine the position of the lamb and, if possible, turn the lamb to its proper position. A lamb in the normal position will be in the same position as the calf in Transparency No. 1. If the lamb cannot be placed in the proper position, it will be necessary to follow the same procedure in assisting the ewe as is suggested for assisting the cow.

After the lamb is born, it should be dried and the mucus removed from its nostrils. It may be necessary to give the lamb artificial respiration to start it breathing. In cold weather, heat should be provided.

The attendant should make sure the lamb nurses, the ewe cleans herself of after-birth, and that the ewe is not constipated. Plenty of water and light feed should be provided for the ewe. The ewe and lamb should be observed several days to watch for possible problems.

References:

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3. Ensminger, M. E., Horses and Horsemanship, The Interstate Printers and Publishers, Danville, Illinois, 1969.
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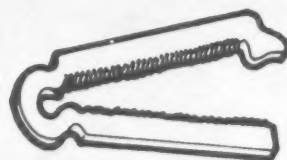


CALF PULLER



PLASTIC GLOVES

PARTURITION



NAVEL CORD CLAMP

EQUIPMENT



OBSTETRICAL CHAIN



VASELINE



DISINFECTANT



IODINE
(2% solution)

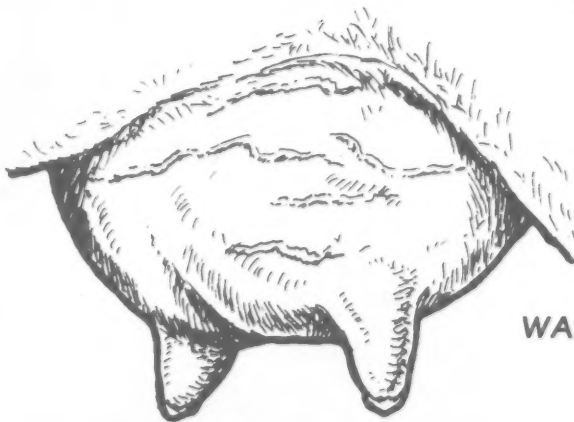
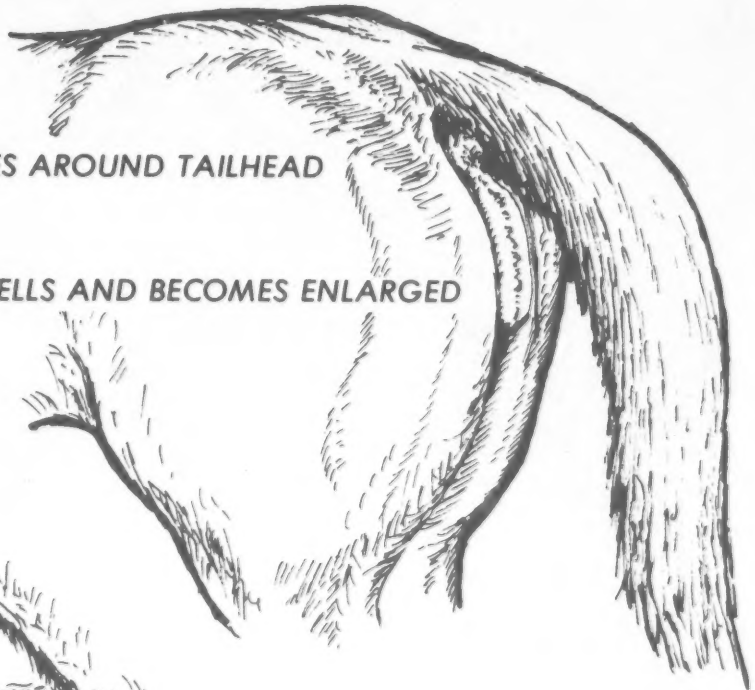
SIGNS OF PARTURITION



DISTENDED UDDERS

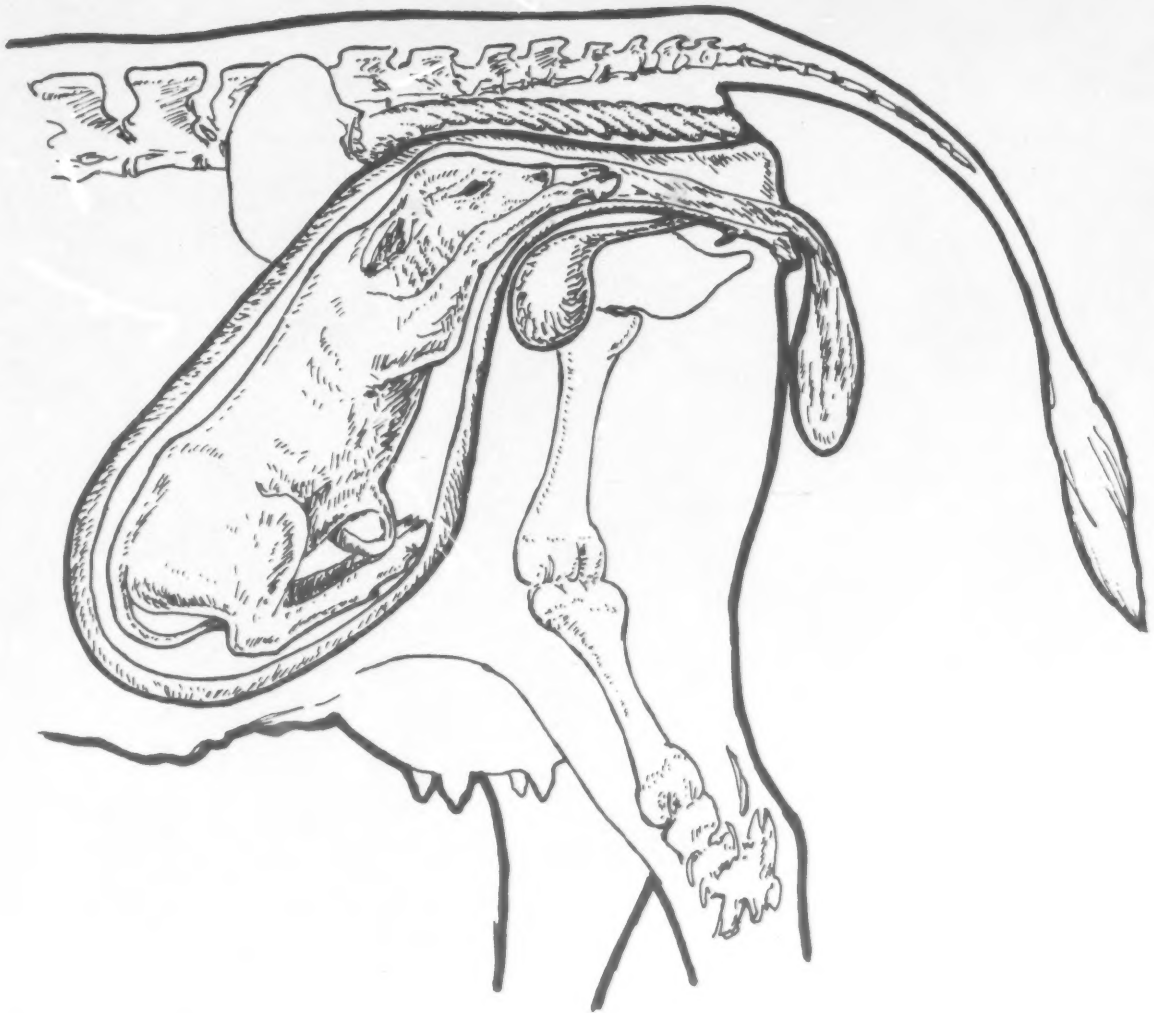
SAGGING OF MUSCLES AROUND TAILHEAD

VULVA SWELLS AND BECOMES ENLARGED



WAXING OVER OF TEATS

NORMAL PRESENTATION



SOME ABNORMAL PRESENTATIONS OF CALVES

ANTERIOR PRESENTATION:
BOTH FORELEGS BENT AT
KNEES



ANTERIOR PRESENTATION:
HEAD UPWARD AND
BACKWARD



ANTERIOR PRESENTATION:
ONE FORELEG BENT AT
KNEE



SOME ABNORMAL PRESENTATIONS OF CALVES

ANTERIOR PRESENTATION:
HIND FEET IN PELVIS



BUTTOCK PRESENTATION:
SHOWING FETUS CORDED



BACK PRESENTATION



ANIMAL SCIENCE

Unit A: Animal Reproduction

Topic 7: Palpation

Note: All terms underlined are in the "Glossary of Terms."

Suggested Procedures and Activities:

1. Introduction

With today's inflation and continued high production costs it is extremely important that cow-calf operations be as efficient as possible. The cost for maintaining each cow in the herd is figured on a basis of each particular operation. The maintenance cost on all cows must be charged against the calf crop for that year. Thus, those cows that don't produce a calf reduce the profits considerably.

In order to survive with a cow-calf operation it is extremely important to maintain a high percentage calf crop each year. Pregnancy diagnosis is one of the best management procedures to be used to help maintain a high percentage calf crop. The technique of palpation for pregnancy is relatively easy and becomes highly accurate with practice. The use of breeding records in palpation is extremely important to help determine whether or not a cow is pregnant. By knowing breeding dates the palpation has the added advantage of knowing the stage of pregnancy the cow is in if she is bred.

2. Equipment Necessary for Palpation

Transparency No. 1

Protective Covering for the Arm & Hand - Since the palpator must insert his hand and arm into the rectum of the cow, it is necessary that he cover them. Plastic or rubber sleeves may be used for this purpose. If rubber sleeves are used, they should be dried after use and covered with talcum powder before storage. No special care need be taken with plastic sleeves as they are disposed of after use.

Lubricant - The lubricant should be applied to the covered hand and arm to facilitate entry into the cow's rectum. Liquid soap is one of the best lubricants, because it provides a slick covering over the arm and does not irritate the cow's rectal cavity as detergents sometimes do.

Transparency No. 2

Chute - The holding chute should be constructed so that the animal can stand on the ground in a normal position. There should be a gate in front of the cow and a pipe or pole for insertion through the chute behind the animal approximately 4 inches above the hocks. The pipe keeps the palpator from being kicked and also prevents the animals from backing up. An entrance gate through the side of the chute should also be provided. It should open to the inside of the chute so that the animals behind the cow being palpated can be closed off when the palpator steps into the chute to begin his work.

The animal's head should not be placed in a stanchion or headgate as this will tend to excite the cow. The floor of the chute should be dirt; but when concrete or wood flooring is used, some type of cleats or cross-slats should be constructed to prevent the cow from slipping.

3. The Reproductive System and Palpation

Determining pregnancy in cattle by palpation is not particularly difficult, but it requires experience, practice, and a thorough knowledge of the cow's reproductive system.

To accurately determine pregnancy, the palpator must insert his hand into the cow's rectum, locate the reproductive tract through the rectal wall, and determine whether a condition of pregnancy exists. Since the operation is performed completely by sense of touch, the palpator must know where all the reproductive organs are located and how they feel at different stages of pregnancy.

The location and feel of the following female reproductive organs and other body parts should be familiar to the palpator.

Transparency No. 3

- a. Vulva - This is the external portion of the female reproductive tract and may be seen as two prominent lips. Although this organ is of no importance in palpation, it can be used as an indicator in the latter stages of pregnancy. During this period the vulva will become swollen and more prominent.
- b. Vagina - The vagina is located just inside the vulva and serves as a depository for sperm during a natural service by a bull. The rear portion of the vagina serves as a common passageway for urine and the passage of young at birth. The vagina is usually the first organ felt during palpation because it is directly under the rectum. It is felt as a soft, spongy cylinder.
- c. Cervix - This organ is located at the upper end of the vagina. It is an important "landmark" in palpation, and it is usually easy to locate because of its hard, gristly feel.

- d. Uterus - This organ lies directly in front of the cervix. The cow's uterus is composed of two uterine horns that are connected. The fertilized egg implants itself in the wall of one of the horns, and the ovum begins to develop. The palpator can follow the two horns by beginning at the upper end of the cervix and following them to their respective ends. The horns are larger at the lower end and taper off in size toward the upper ends. The location and feel of the uterus will depend upon the stage of pregnancy and the age of the cow.
- e. Fallopian Tubes - These small tubes are located at the upper ends of the uterine horns. They act as the passageway for the egg as it moves into one of the uterine horns.
- f. Ovaries - The female egg develops in a follicle on the ovary. The ovaries are suspended in the body cavity by ligaments attached to the top of the abdominal cavity. They are located approximately at the ends of the fallopian tubes on each side of the body cavity. In a normal cow they are about 1/2 inch wide, 3/4 inch deep, and 1 inch long and should feel firm.

Transparencies Nos. 4 & 5

- g. Pelvis - The pelvis forms a bone cradle for the open reproductive system. As pregnancy advances, the cervix and uterus move down over the pelvic ridge and into the body cavity. Because the pelvis never moves, it is an excellent "landmark" in palpation. It can be felt by pressing down through the rectal wall immediately after the palpator pushes his hand into the cow.
- h. Embryonic Vesicles - After the fertilized ovum has moved into the uterine horn and begun to develop, it is surrounded by a fluid-filled sac. This sac causes an enlarged area in the horn.
- i. Caruncles - The caruncles are raised prominences that line the walls of the uterus. They serve as connecting points for the fetal membranes. After connection at about 38 days, they serve as nutrient and waste exchange between the fetus and its dam.
- j. Cotyledons - These are the "buttons" on the fetal membranes that attach themselves to the caruncles that line the uterus.
- k. Broad Ligament - This is the support for the uterus.
- l. Uterine Artery - This artery is the main blood supply from the dam to the developing fetus.

4. Palpation

Transparency No. 6

Palpation may be done with either hand. One hand can be used to grasp the cow's tail as leverage. The covered, lubricated hand should be shaped into a wedge by bringing the fingers close together. This will help in the initial thrust into the rectum. As the hand goes through the cow's anus, the hand should be formed into a fist to push aside fecal material and straighten the folds of the rectum.

Beginning palpators may wish to clean the fecal matter from the cow's rectum, especially if the animals have been on dry range. Cleaning the rectum will increase the sense of feel when the palpator is inexperienced.

Feeling through the rectal wall is much like feeling through a layer of thin rubber. The thickness will vary slightly with individual cows and may vary greatly between breeds. The heavier breeds, such as Santa Gertrudis and Charolais, usually have thicker rectal walls than do smaller breeds. The larger body cavity of the heavier breeds may also present difficulties in locating the reproductive tract after the palpator's hand has passed the pelvic ridge.

The palpator should locate a point of identification immediately after entering the rectum. Finding the pelvic ridge is a good place to start. If the animal is not pregnant the reproductive tract will normally lie just to the rear of the ridge. In older cows the uterine horns of the open tract may hang slightly over the pelvic ridge. As pregnancy advances and the cervix and uterus move over the ridge and into the body cavity, the palpator will have to feel past the ridge and downward.

5. Determining Stages of Pregnancy

Transparency No. 7

- a. 30-Day Pregnancy - Determining pregnancy at this early stage takes a great amount of skill and practice. Palpation at this stage should be accompanied by good breeding records so that the palpator can check the breeding dates of the animals.

In a 30-day pregnancy the uterus will be filled with fluid and feel slightly thinner. One of the horns will be enlarged a little more than the other. By running each horn between the fingers the enlargement in one horn can be felt. This enlargement is the embryonic vesicle. The vesicle is about 3/4 inch in diameter and filled tightly with fluid. It has much the same feel as a balloon filled with water. On the same side as the enlargement may be found a corpus luteum on the ovary. The corpus luteum will be a hard teat-like projection on the surface of the ovary. At this stage of pregnancy, the reproductive tract will still lie on the floor of the pelvis.

Transparency No. 8

- b. 45-Day Pregnancy - The embryo attaches to the uterine wall around the 38th day. From this time on it is called a fetus.

In this stage the fetus is about one inch long. The vesicle around it has become somewhat egg shaped and measures one to one and one-half inches in length. The uterine horn containing the fetus has become larger and thinner walled. The vesicle membranes are beginning to attach themselves to the caruncles of the uterine wall. Therefore the palpator should take care not to move the fetus about in the uterus. Excessive movement at this time could break the attachments and cause the death of the fetus.

Transparency No. 9

- c. 60-Day Pregnancy - The uterus has now enlarged until one horn is about the size of a banana and measures 8 to 10 inches long. The weight of the fetus and other contents has pulled the uterus over the pelvic ridge into the body cavity. The fetus measures 2 1/2 inches in length, and the embryonic vesicles are still prominent. The best method of feeling the fetus at this stage is to gently tap the uterus with your hand. This will cause the fetus to swing back and forth and bump against the embryonic vesicles and uterine walls. The bumping can be felt by the palpator. In this stage the cervix is still in the pelvic cradle, and the ovaries are suspended rather high in relation to the uterus. The corpus luteum will again be found on the ovary corresponding to the enlarged uterine horn.

Transparency No. 10

- d. 90-Day Pregnancy - The uterus in this stage is considerably larger because of increased fluid and fetal growth. The fetus is now about 6 1/2 inches long and is located on the floor of the body cavity. The cervix may be pulled over the pelvic ridge into the body cavity. The stretched uterus has pulled the ovaries down so that they may be palpated on either side of the uterus.

Because of the low position of the uterus, palpating the fetus in this stage may be difficult. The palpator may have to consider other factors to confirm pregnancy. The palpation of the uterine artery may be used to accomplish this. The artery, which carries blood to the developing fetus, is located in the forward fold of the ligament that supports the uterus. At this stage it is 1/8 to 3/16 inch in diameter and has a characteristic "whirring" pulsation as the blood moves through it. It can be felt by pressing it against the left forward side of the pelvis. Care must be taken not to confuse the femoral artery, which lies in the muscle of the thigh. To confirm the presence of the uterine artery, attempt to move it from side to side. The femoral artery cannot be moved and does not have the "whirring" pulsation of the uterine artery. Perhaps the best indication at this time (in the absence of the fetus) is the presence

of the cotyledons on the uterus. They may be felt as flattened, egg shaped masses on the uterus. They will feel slightly firmer than the uterus and will measure $3/4$ to 1 inch across.

Transparency No. 11

- e. 120-Day Pregnancy - The fetus in this stage is 10 to 12 inches long and is still on the floor of the body cavity. The head of the fetus is about the size of a lemon and may be the first portion of the fetus that the palpator touches. Since the fetus is larger in this stage, it is normally easier to locate. The cotyledons have enlarged to about 1 to $1\frac{1}{2}$ inches in length, and the uterine artery has increased in size.

Transparency No. 12

- f. 150-Day Pregnancy - The main change from this stage until birth is in the increased size of the fetus. At 150 days the fetus is the size of a large cat. The uterine artery is $1/4$ to $3/8$ inch in diameter, and the cotyledons are 2 to $2\frac{1}{2}$ inches in diameter. Palpation of the fetus may still be difficult because of its low position in the body cavity.

Transparency No. 13

- g. 180-Day Pregnancy - At this stage the fetus is still deep in the body cavity. The uterine artery is $3/8$ to $1/2$ inch in diameter, and the cotyledons are larger. From 180 days until birth, the fetus can be made to move by grasping the feet, legs, or nose.

Transparency No. 14

- h. Over 7-Month Pregnancy - From 7 months until calving, the fetus may be easily felt because of the increase in fetal size.

6. Areas of Confusion in Palpation

The following areas may cause the beginning palpator to become confused or miscalculate pregnancy:

- a. Paunch (Rumen) - This portion of the digestive tract may be felt just after the initial thrust into the rectum. It is directly forward and to the left and, when full of feed, has a firm, plastic feel. It may have the shape of the end of a football. When pressed an indentation will form which slowly fills back in and smooths over. The paunch is often mistaken for pregnancy under careless examination.

- b. **Pyometra** - This condition may often be confused with early pregnancy. Pyometra is caused when there is an infection in the uterus and white blood cells form to combat the disease organism. The uterus may be fluid to the touch or be somewhat solidified, depending on the stage of the infection. Palpating for cotyledons and the uterine artery will prove or disprove pregnancy.
- c. **Large Uterus** - After a cow has calved several times, her uterus may not return to normal size. The uterus may be over the pelvic ridge as in a 3 or 4 month pregnancy. Careful palpation will show an absence of uterine fluids and cotyledons.
- d. **Enlarged Cervix** - At times, in Brahman or Brahman crossbred cattle, a cervix that is large and has the feel of a developing fetus may be found. Careful tracing of the reproductive tract will distinguish between the two.
- e. **Bladder** - The bladder, when full, has the feel of a 60 to 75 day pregnancy. Careful palpation will show the bladder to be a single body with no horns, as is the case with the uterus.

7. Summary of Palpation

The key to accurate palpation is experience. While the cow herd is being palpated is a good time to cull cows for other reasons. Cows that are slow to conceive, calve late, and produce unthrifty calves should be culled.

Palpation accuracy can usually be increased by removing all bulls from the herd 45 days before palpating. This will allow the pregnancies to develop to a stage at which pregnancy diagnosis will be easier. Remember also to keep good breeding records as an aid to the palpator.

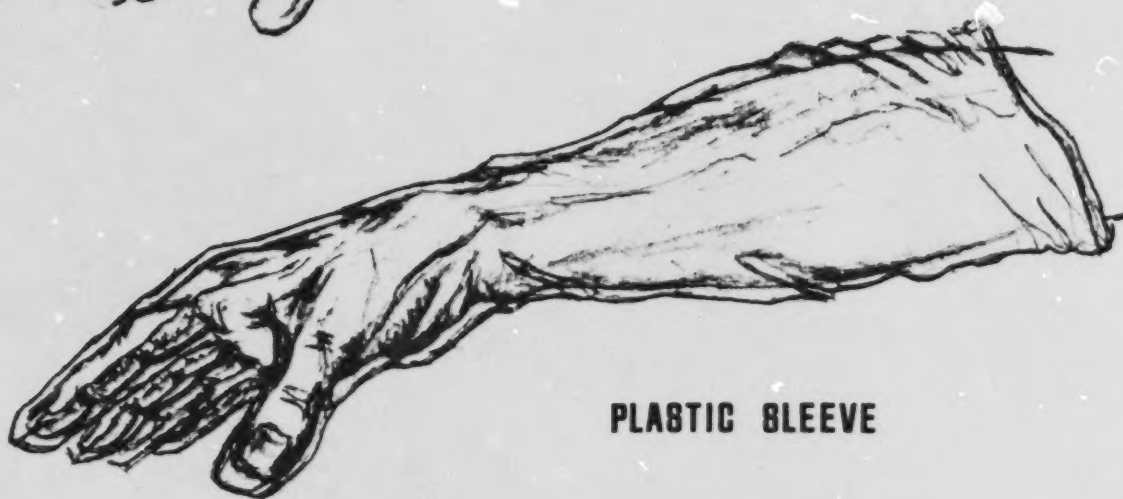
References:

1. "Determining Pregnancy in Cattle," Texas Agricultural Extension Bulletin, B-1077.
2. Ensminger, M.E., The Stockman's Handbook, The Interstate Printers and Publishers, Inc., Danville, Illinois.

PALPATION EQUIPMENT

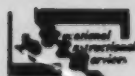


RUBBER SLEEVE

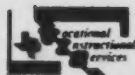
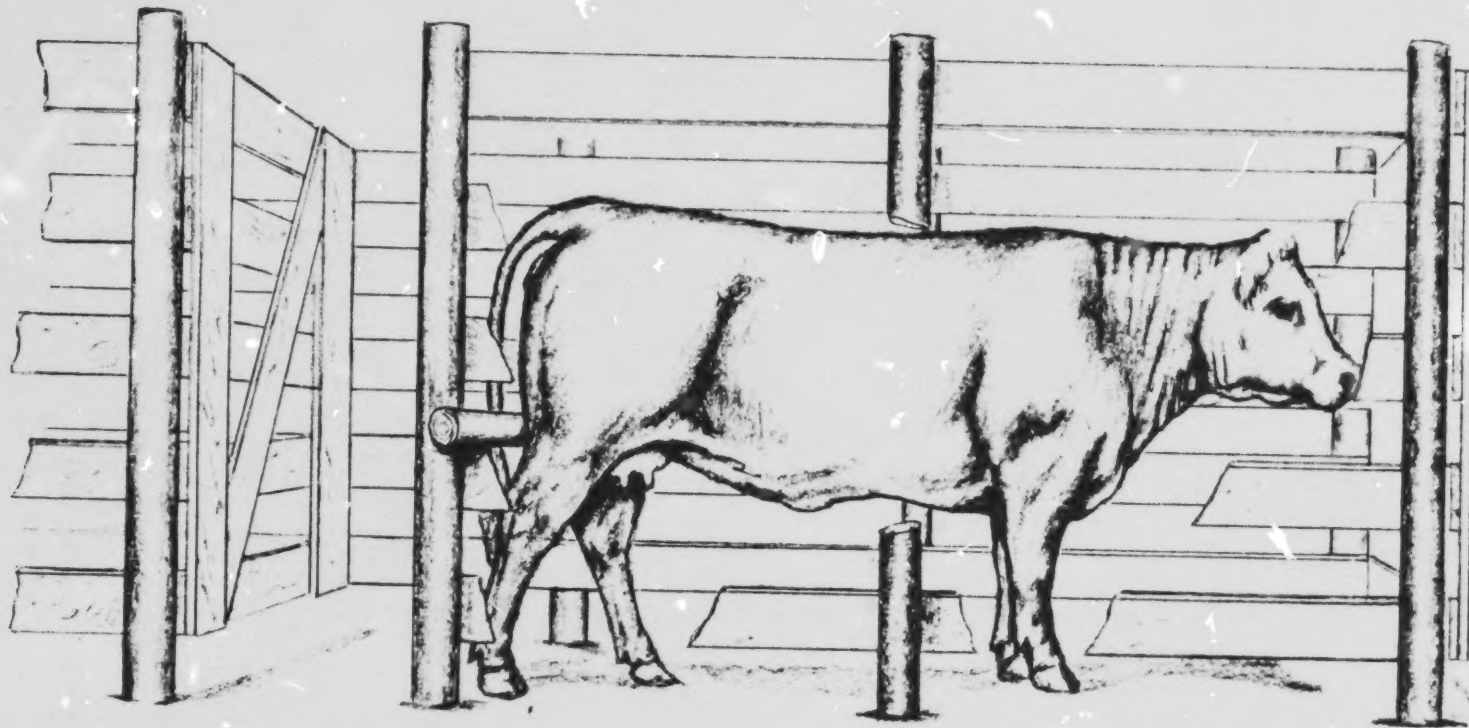


PLASTIC SLEEVE

LUBRICANT



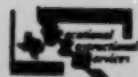
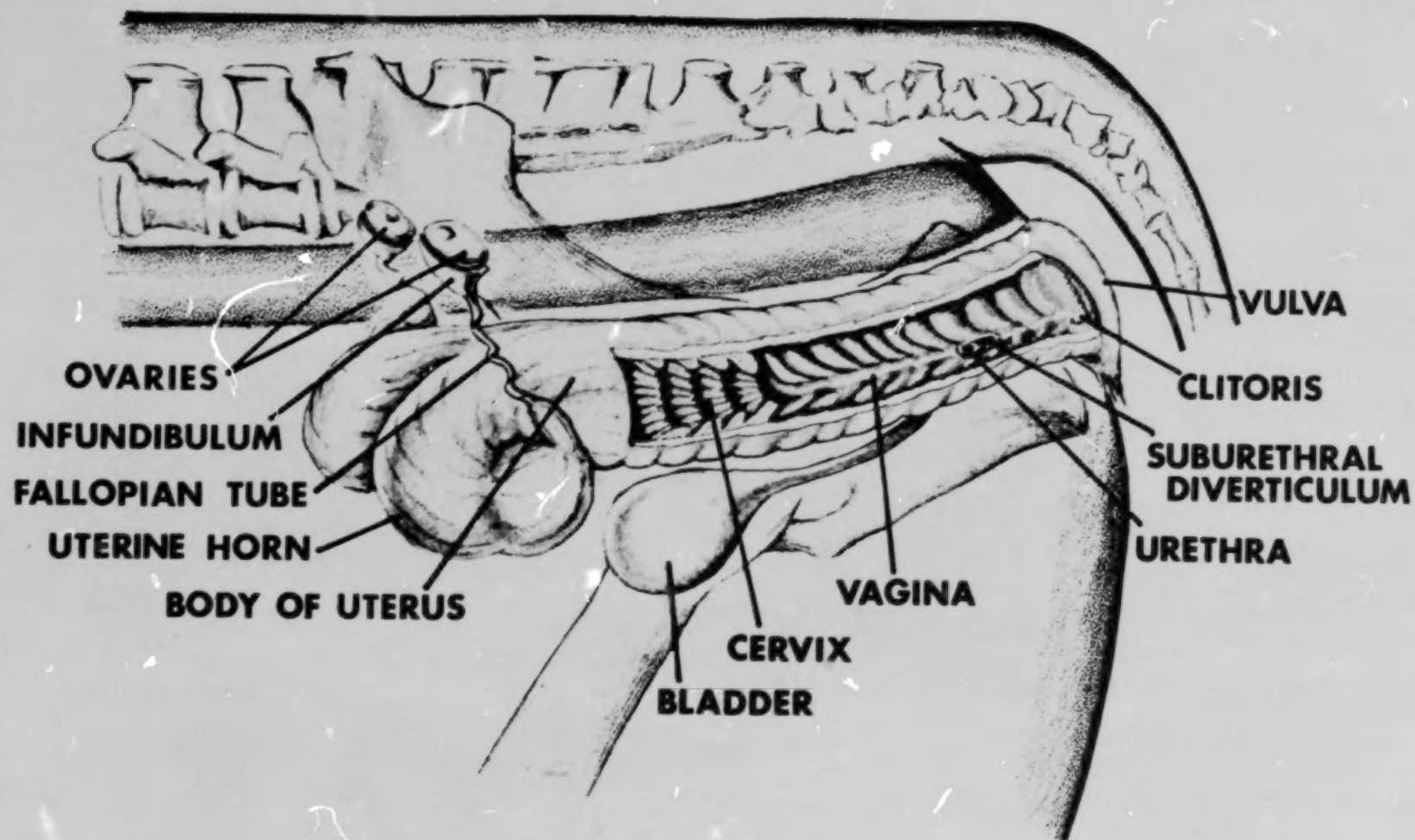
HOLDING CHUTE for PALPATION & INSEMINATION



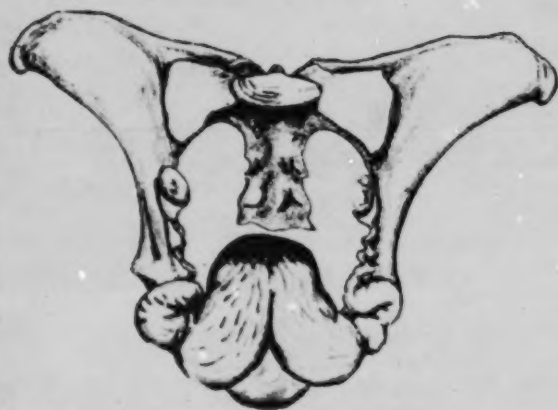
V.A.III

II-A-7
No. 2

FEMALE REPRODUCTIVE TRACT



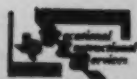
THE RELATIONSHIP OF THE REPRODUCTIVE TRACT TO THE PELVIS



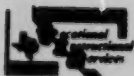
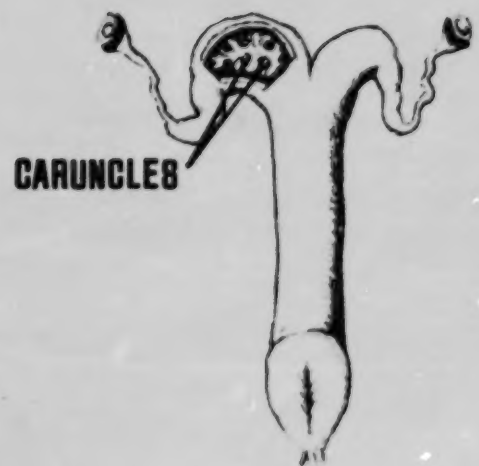
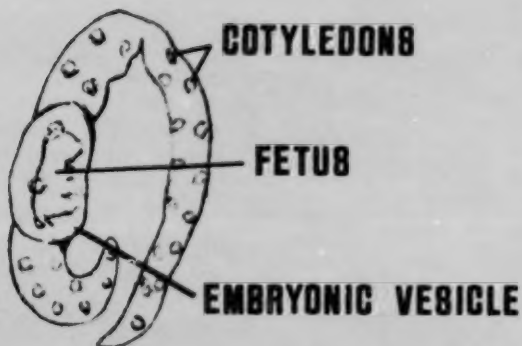
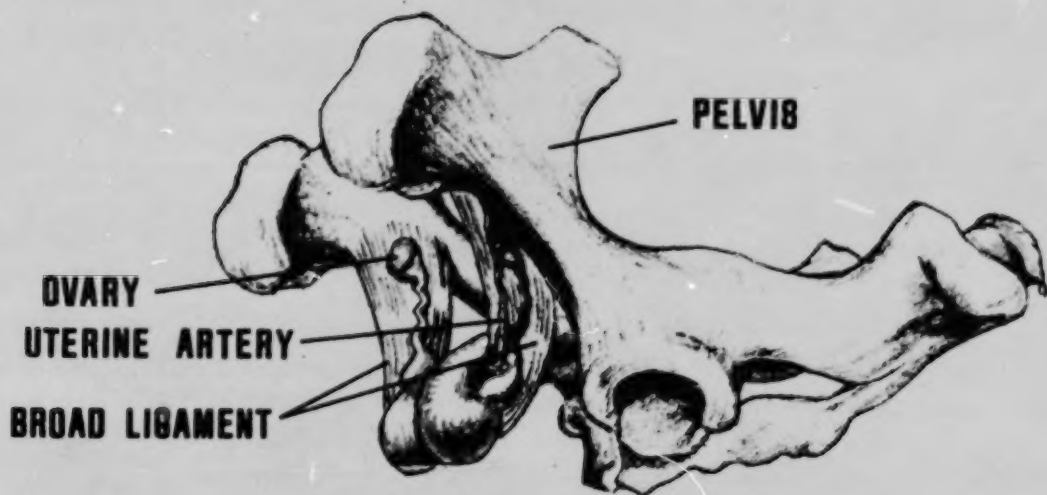
Front view



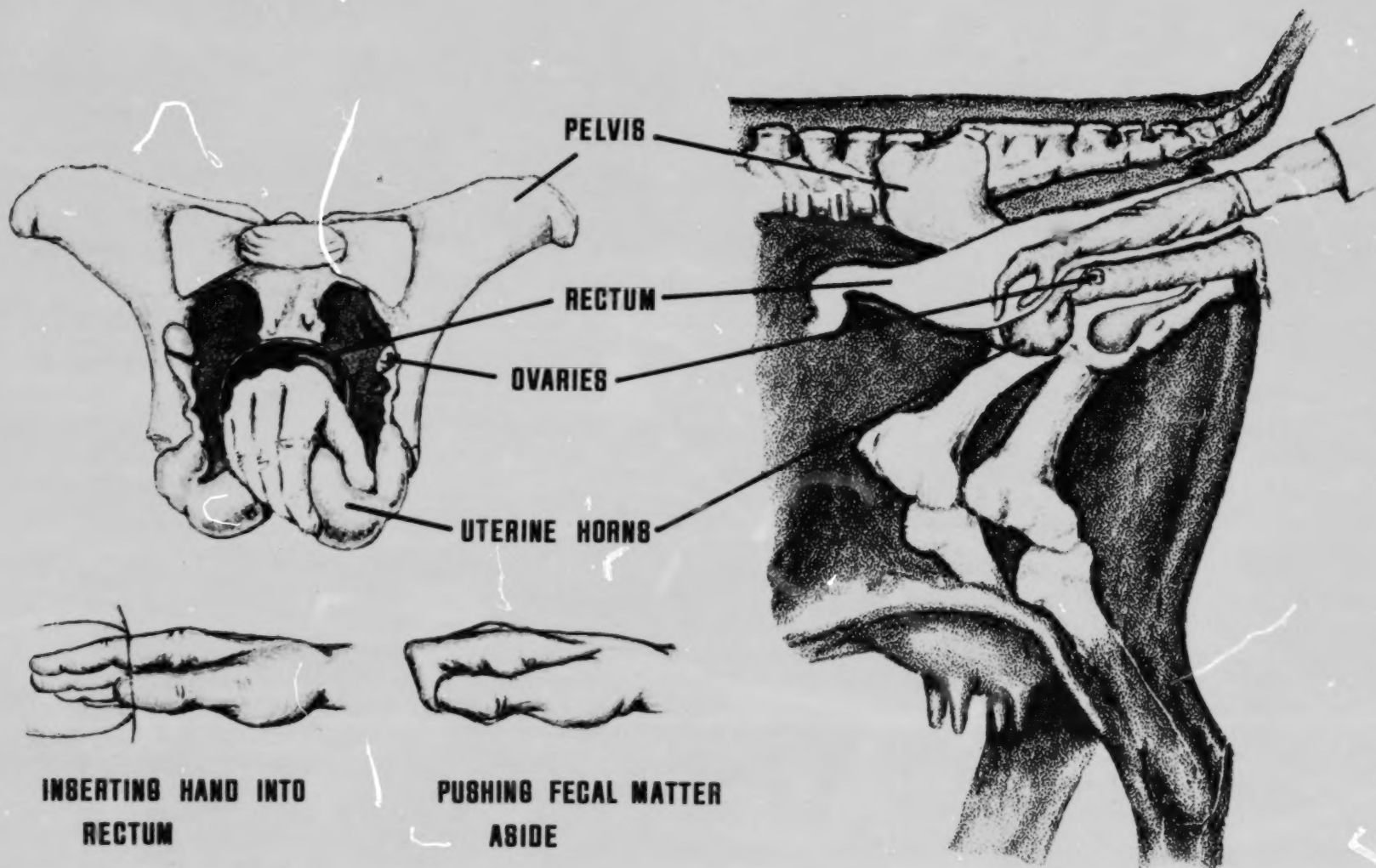
Side view



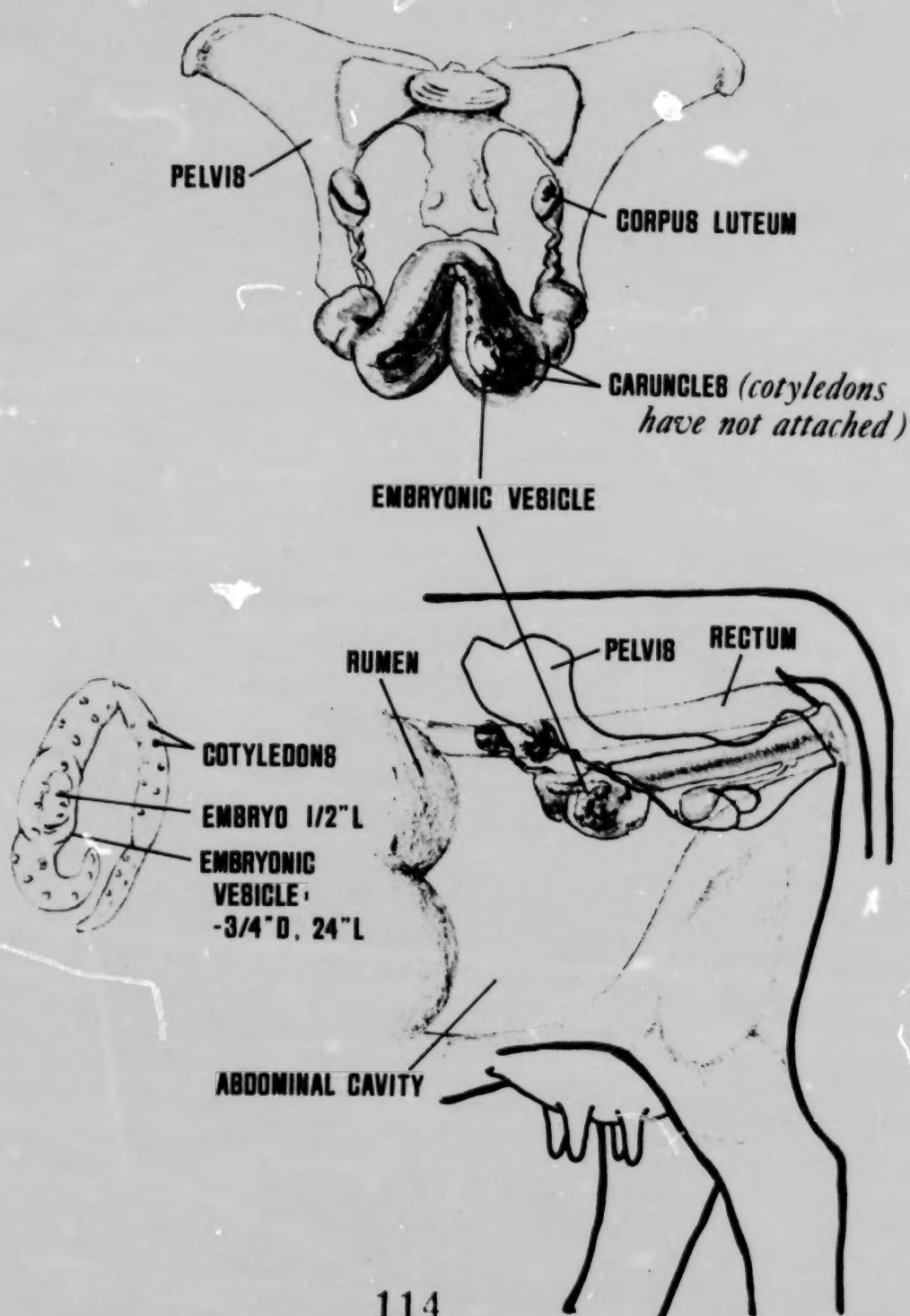
FEMALE REPRODUCTIVE TRACT



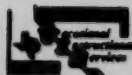
POSITION OF THE HAND IN PALPATION



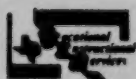
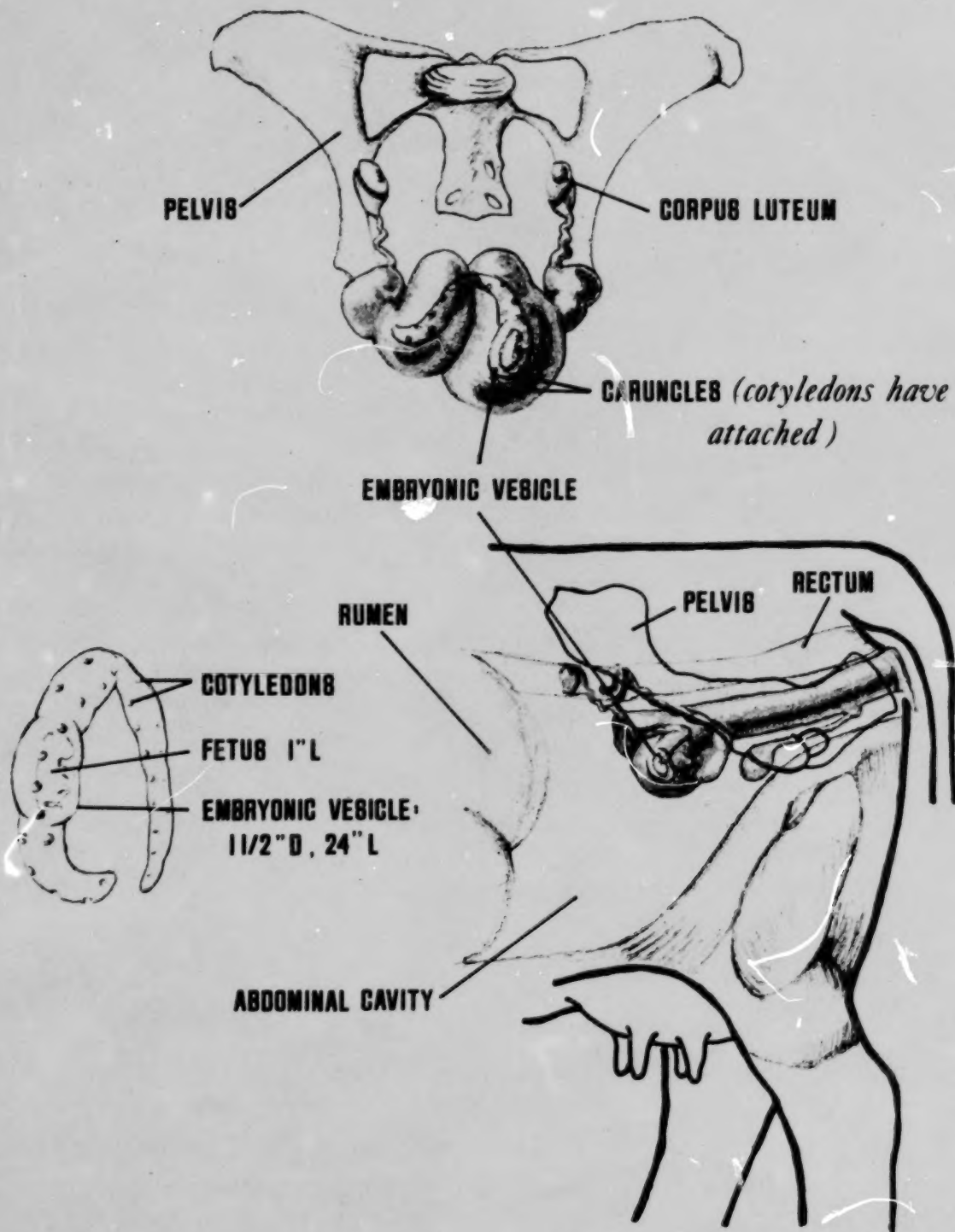
30 DAY PREGNANCY



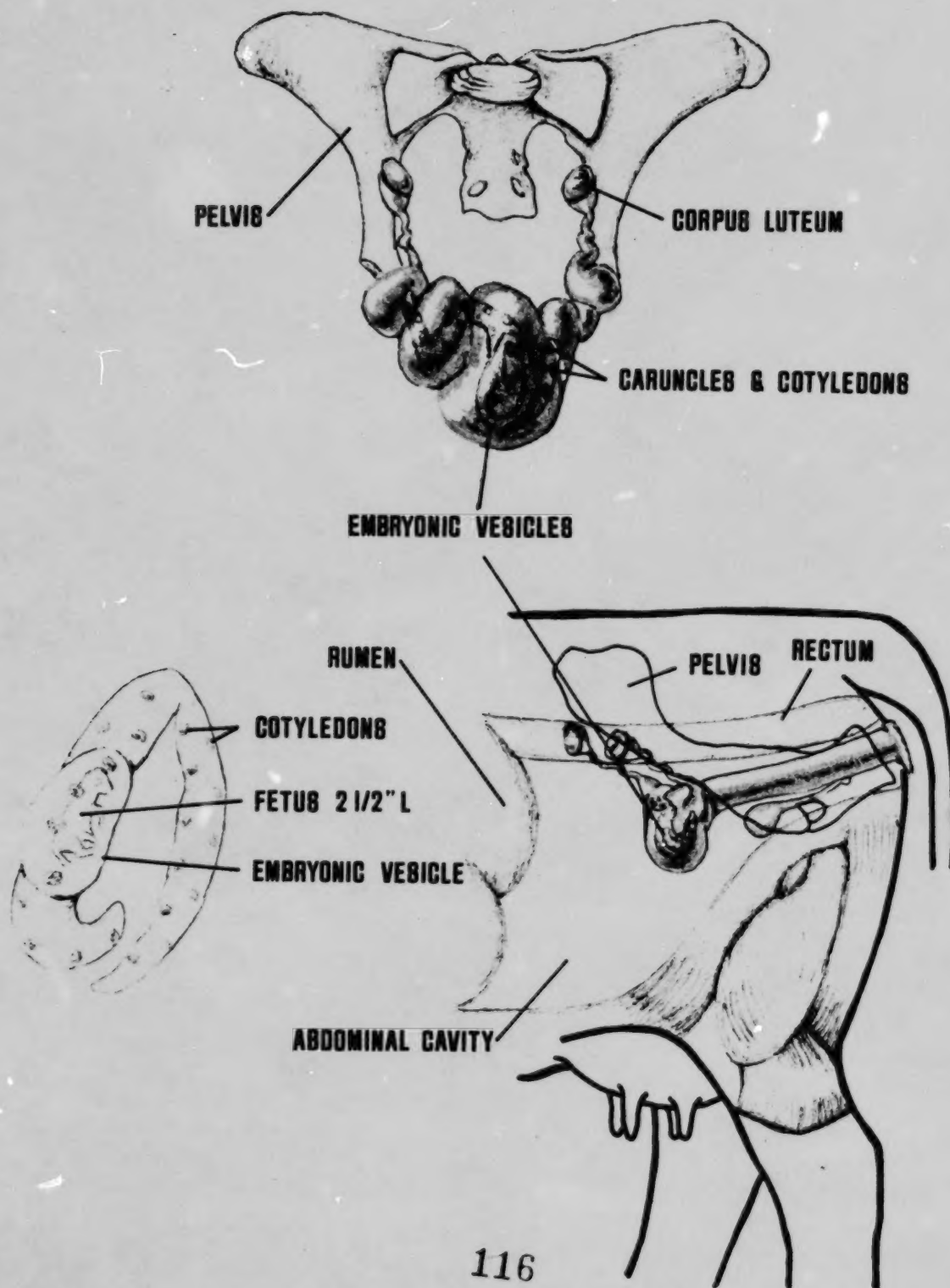
114



45 DAY PREGNANCY

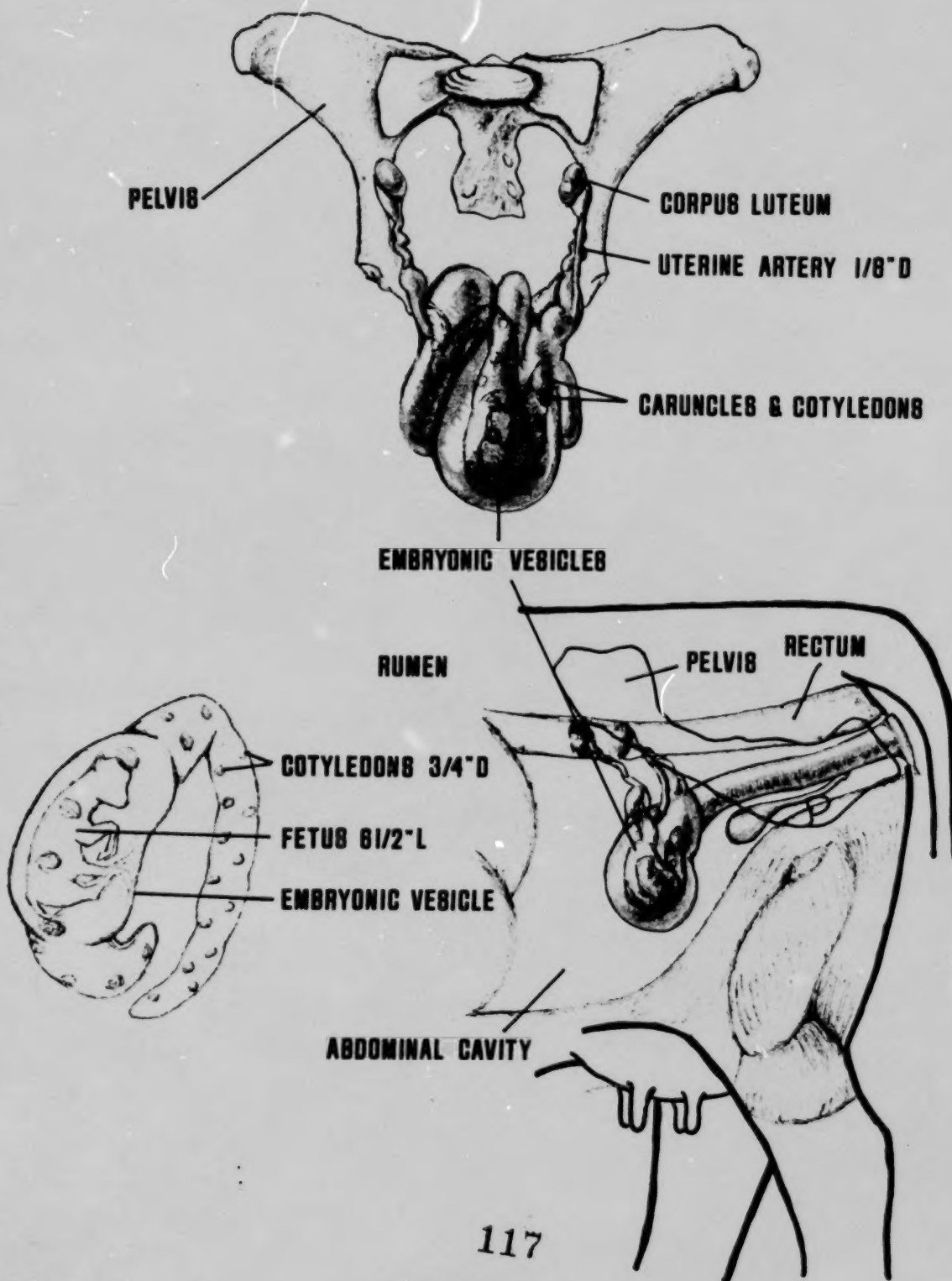


60 DAY PREGNANCY

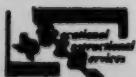


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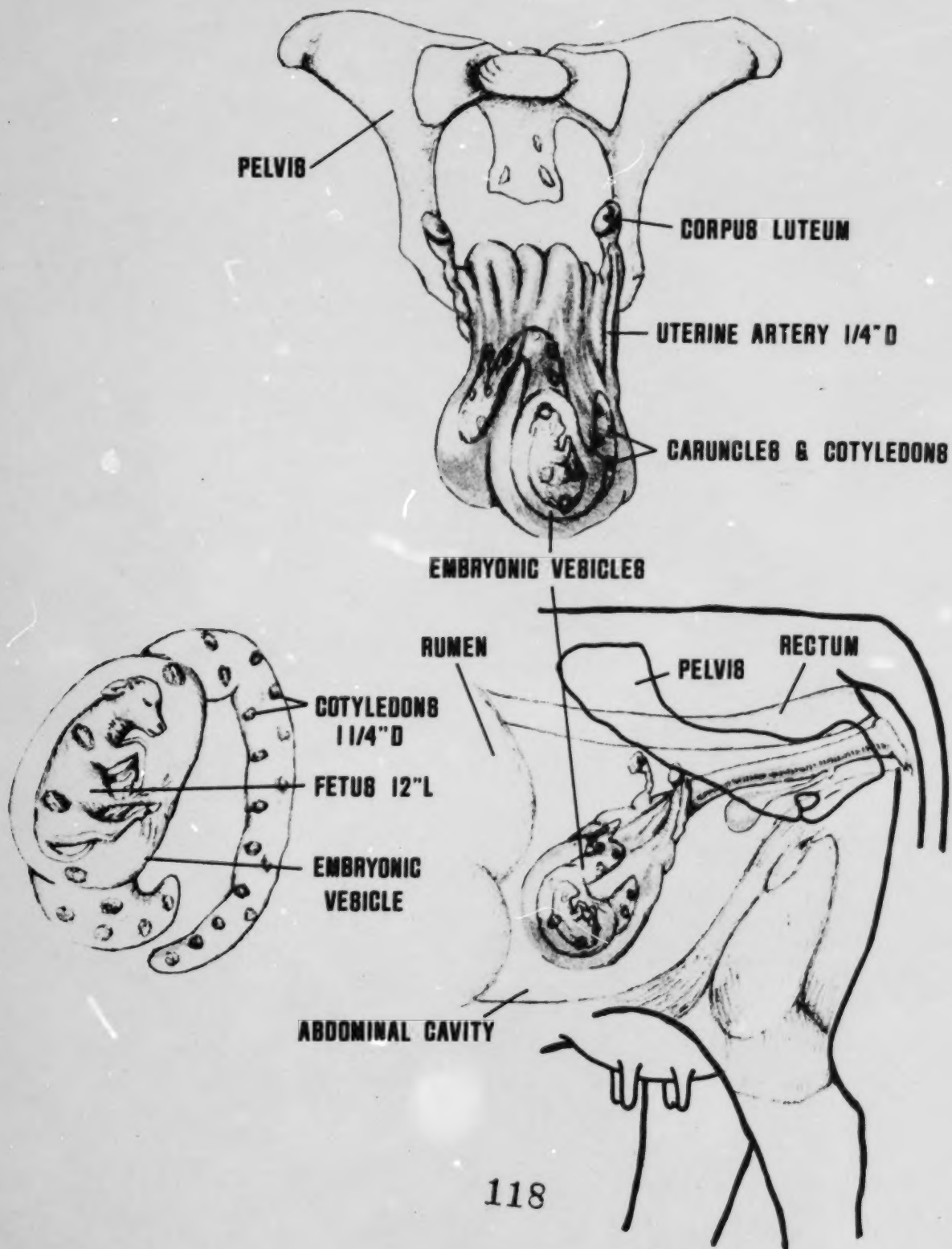
90 DAY PREGNANCY



117



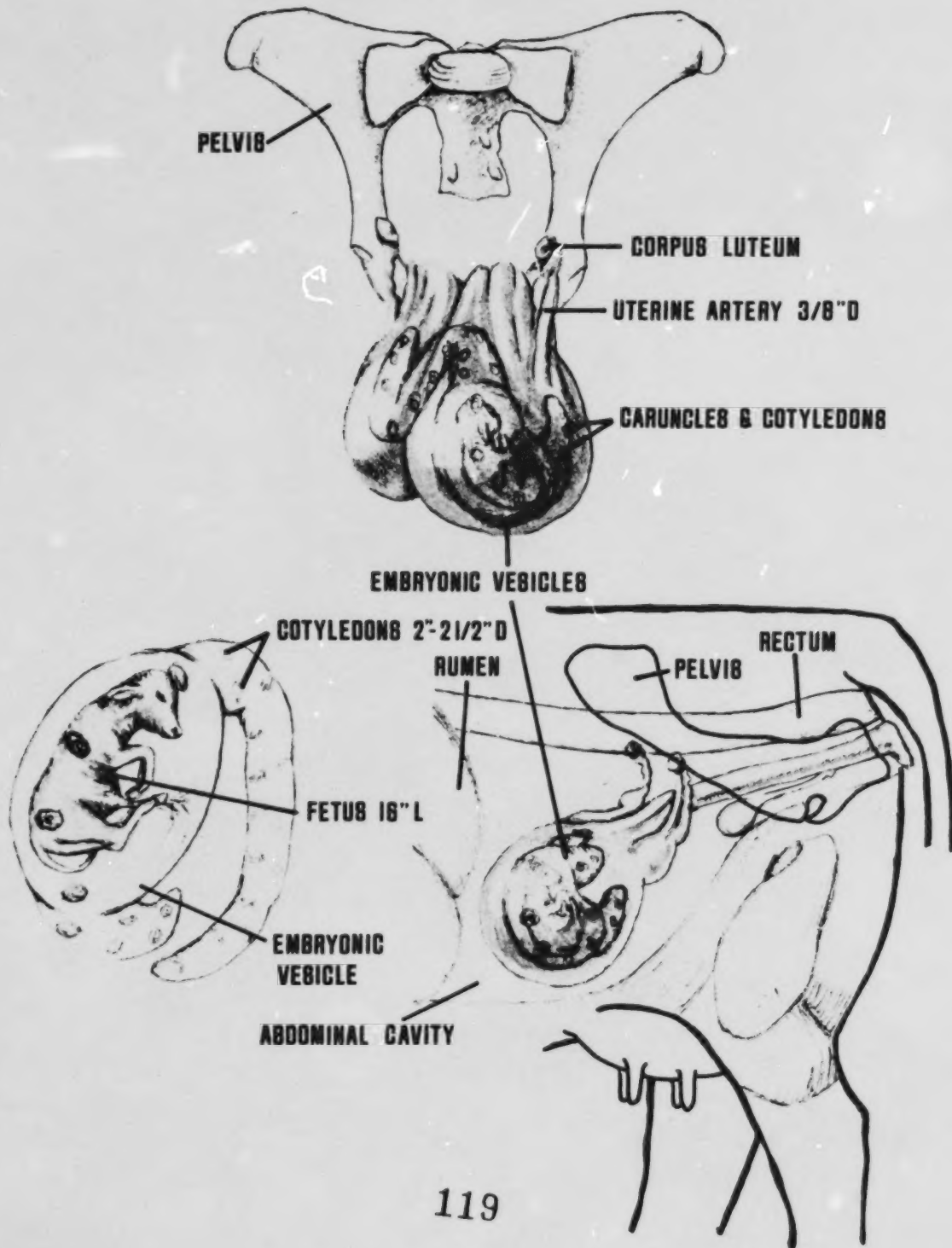
120 DAY PREGNANCY



118



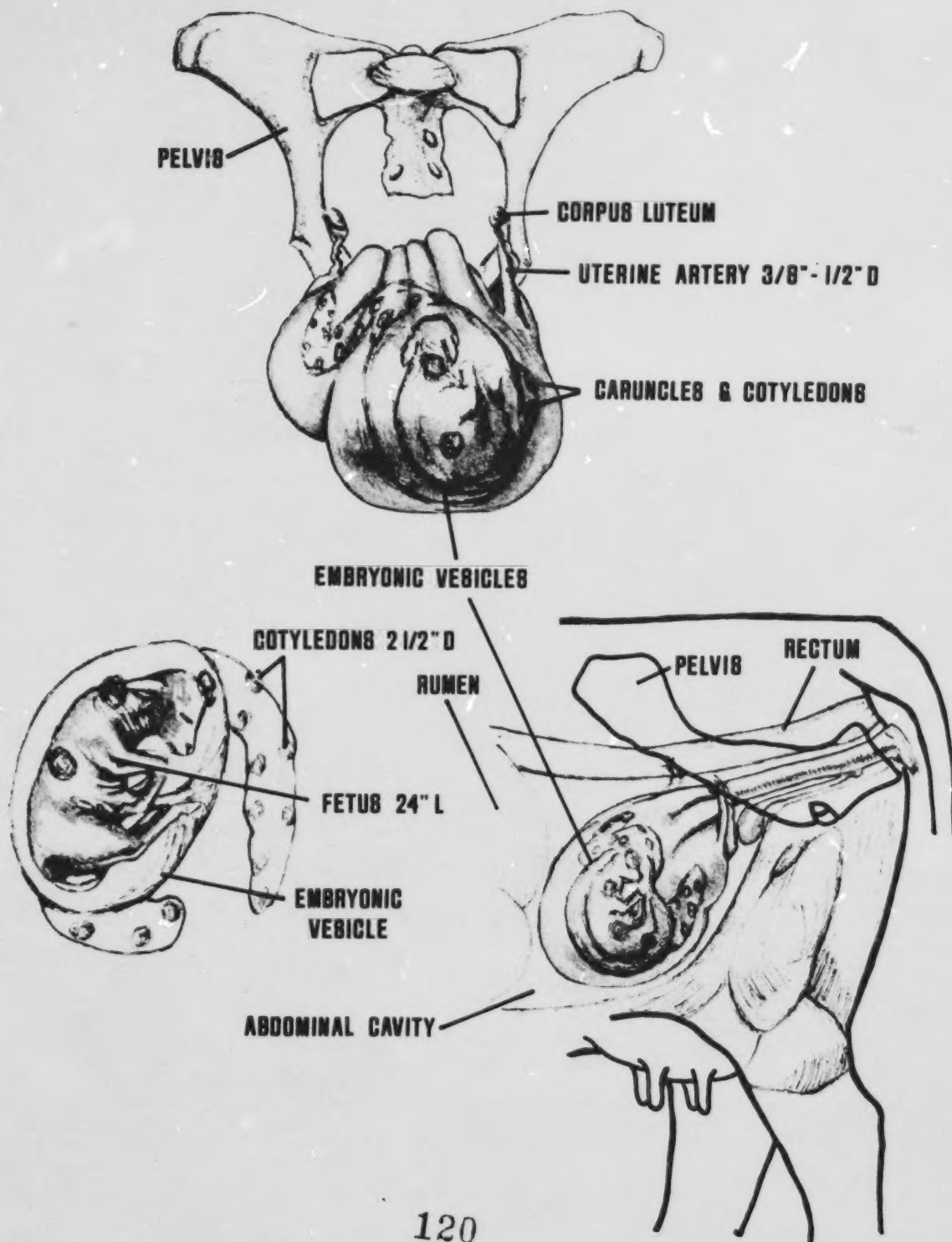
150 DAY PREGNANCY



119



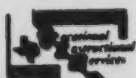
180 DAY PREGNANCY



120

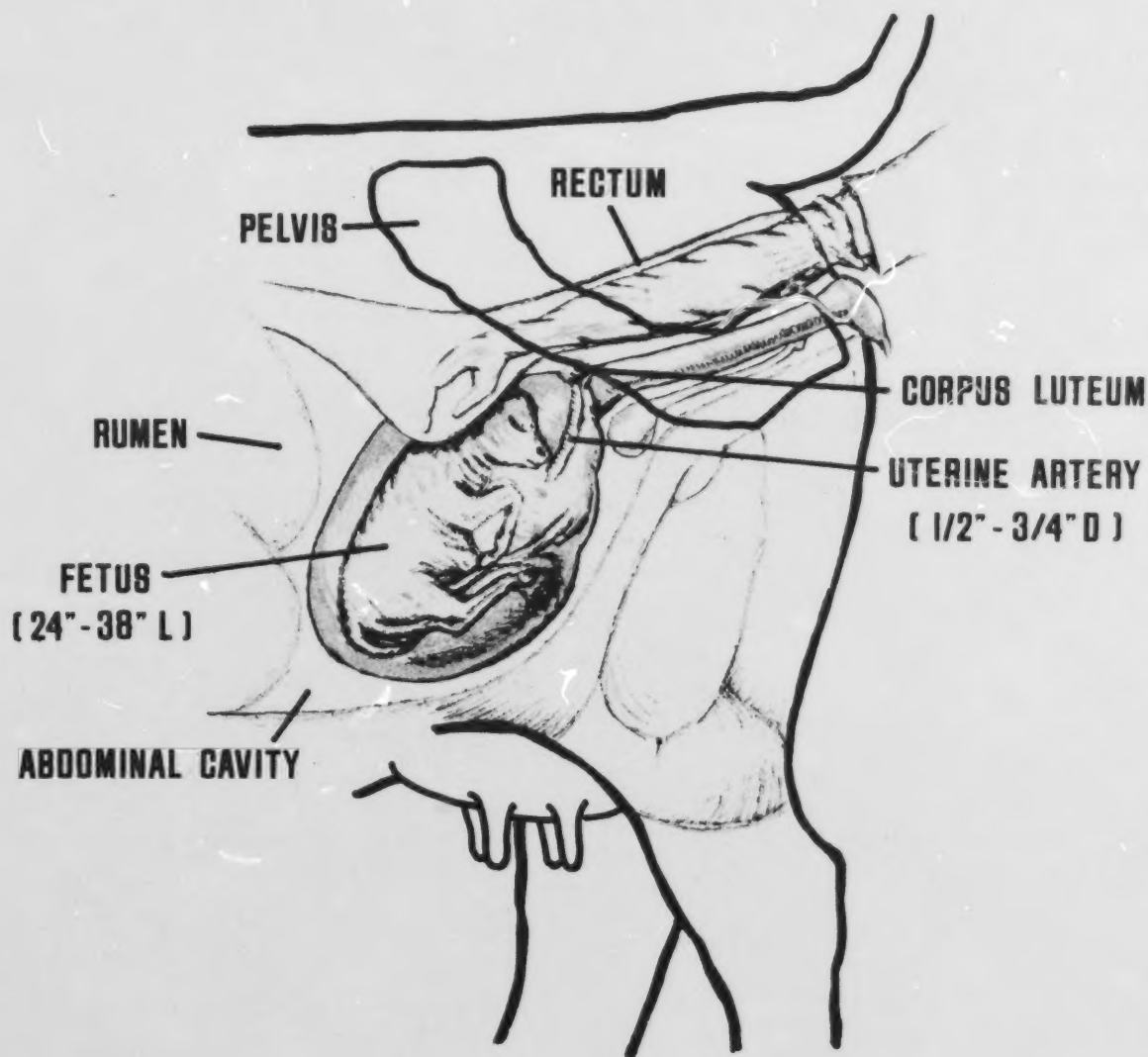
V.A.III

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No. 13

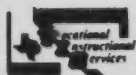


210 DAYS TO PARTURITION

(FETUS MAY BE FELT)



121 V. A. III



II-A-7
No. 14

ANIMAL SCIENCE

Unit A: Animal Reproduction

Topic 8: Artificial Insemination

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

1. History of Artificial Breeding

Artificial insemination, by definition, is the deposition of spermatozoa in the female genitalia by artificial rather than by natural means.

Early Development

Legend has it that artificial insemination had its origin in 1322, at which time an Arab chieftain used artificial methods to impregnate a prized mare with semen stealthily collected by night from the sheath of a beautiful stallion belonging to an enemy tribe.

The first scientific research in artificial insemination of domestic animals was conducted with dogs by L. Spallanzani, an Italian physiologist, in 1780.

A century later, American veterinarians employed artificial means to get mares in foal that persistently had failed to settle to natural service.

The Russians, with E. I. Ivanoff as the leading pioneer, were the first to use artificial breeding on a large scale. Starting about 1899, Ivanoff first experimented with horses, and he later succeeded with insemination of birds. He also was the first to succeed with cattle and sheep. In 1922, Ivanoff was called upon by the Russian government to apply his findings in an effort to reestablish the livestock industry following its depletion in World War I. Crude as his methods were, his work with horses must be considered the foundation upon which the success of more recent work is based.

The Danes acquired the technique from the Russians, and, in 1936, organized their first cooperative artificial breeding association. It is reported that the Danes, in 1951, inseminated some 914,000 cows, or approximately 55 percent of all dairy cattle in their nation.

Following World War II, British scientists made wide use of artificial insemination in reestablishing the livestock industry of England.

Artificial Breeding in the United States

In 1937, the North Central School of Agriculture and Experiment Station, Grand Rapids, Minnesota, conducted the first large scale demonstration of artificial insemination of dairy cattle in this country. Today, artificial insemination is still used more extensively with dairy cattle than with any other class of farm animals. In 1965, 44 percent of dairy cows and heifers (6,301,178 head) were bred by artificial insemination. In that same year, 615,147 head of beef cattle were bred by artificial insemination. The average number of cows bred per bull increased from 228 in 1939 - when the first artificial breeding association was organized in this country - to 3,053 in 1965. This figure represents approximately 100 times more than by natural service. Semen from some outstanding sires is now being used to breed 10,000 to 15,000 cows annually.

2. Why Breed Artificially?

Transparency No. 1

There are a number of benefits which can be realized to the fullest extent by using artificial insemination:

a. Maximum Use of Outstanding Sires

Bulls used artificially are bred to enough cows to allow much more critical selection and to prove, by progeny testing, their ability to sire fast-gaining, high-quality calves. This is economically possible because A.I. bulls may be bred to 100,000 cows or more, whereas the average for natural service would be closer to 200 cows in the lifetime of a bull.

b. Greatly Increased Uniformity

The use of artificial insemination makes possible the development of large numbers of animals within a superior family, thus providing uniformity and giving a better basis for a constructive breeding program.

Under optimum conditions, it has also been established that the calving season can be shortened with a further improvement in uniformity.

c. Possible to Overcome Certain Physical Handicaps to Mating

Artificial insemination permits (a) mating animals of greatly different sizes - for example, use of heavy mature bulls on yearling heifers and (b) use of stifted or otherwise crippled sires that are unable to perform natural service. Also, it may be useful to overcome geographic or physical limitations in hybridization.

d. Lessens Sire Cost

In most herds, artificial insemination is less expensive than the ownership of a worth-while sire together with the costs of feed, housing, and labor.

e. Alleviates Danger and Bother of Keeping a Sire

The stockman may eliminate the necessity of maintaining a sire, and he has the choice of breeding services from a wider selection of sires.

f. Reduces the Costs and Delays of Using Infertile Sires

Because the breeding efficiency of A.I. sires is constantly checked, it reduces the likelihood of breeding females to a sire that has low fertility, or one that is sterile.

g. Better Health Protection

Artificial insemination stops venereal contact. Reproductive problems in individual females are more easily detected.

h. Improved Herd Records

The sire of each offspring is known, the breeding date is known, and improved culling and management result from closer herd observation.

i. Increases Profits

The offspring of outstanding sires are usually better and more efficient producers, and thus more profitable.

j. Increases Pride of Ownership

The ownership of progeny of outstanding sires inevitably makes for pride of ownership.

3. Limitations of Artificial Insemination

Transparency No. 2

Artificial insemination, like many other techniques, is not without its limitations. Some of these are:

a. Requires Skilled Technician

Proper training and experience are essential to be successful with artificial insemination.

b. Must Conform to Physiological Principles

Much false information concerning the usefulness of artificial insemination has been encountered - for example, the belief that females will conceive if artificially inseminated at any time during the estrus cycle.

c. May Restrict the Sire Market

As the use of artificial insemination increases, the market demand for poor or average sires will decrease. A sizeable number of the nation's beef cattle are still bred to scrub or grade bulls.

d. May Increase the Spread of Disease

Carelessness or ignorance in the use of artificial insemination could result in the rapid spread of disease; however, no outbreaks have been reported.

e. May be Subject to Certain Abuses

The integrity and character of the technician must be above reproach as semen is being handled and transported from farm to farm. Trained workers can detect differences in the spermatozoa of the bull, ram, boar, stallion, or cock; but even the most skilled scientist is unable to differentiate between the semen of males of the same species.

f. May Accentuate the Damage of a Poor Sire

Because of the increased number of progeny possible, when a male sires the wrong type of offspring his damage is merely increased; however, the use of tried and proven sires eliminates the possibility of using a genetically inferior sire.

g. Requires Capital and Management Ability

Considerable capital and competent managerial ability are necessary to initiate and operate an artificial breeding organization. In the past 25 years, 240 organizations have tried to develop in the business of artificial insemination of cattle, but 4 out of 5 have failed. In 1965, 42 remained; of these, 20 did 75 percent of the business.

4. The Function of the Male in Artificial Insemination

An understanding of the structure and functioning of the organs of reproduction is necessary before intelligent use can be made of the techniques of artificial insemination.

The main function of the male in reproduction is the production of male sex cells, or sperm cells (spermatozoa), which are needed to fertilize the eggs of the female. In natural mating the male deposits these spermatozoa in the female reproductive tract.

Transparency No. 3

The reproductive organs of the bull consist of the testicles and epididymides (carried in the scrotum), vas deferens, ampullae, urethra, accessory glands, and penis. The testicles produce the sperm cells and the male sex hormone, testosterone. The male hormone causes the development of male characteristics such as the heavy neck and shoulders and the deep voice of a bull.

The formation of sperm cells takes place in very small tubes in the testicles. Normally the testicles are found suspended in the scrotum. By raising or lowering the testes, the scrotum provides a relatively constant temperature (lower than that of the body) which is essential for sperm production. Sperm produced in the testes pass into the coiled tube, or epididymis, that lies along the back side of the testicle. The epididymis serves as a storehouse where millions of sperm mature, or ripen, so they are capable of fertilizing an egg. At the time of mating, or ejaculation, sperm are carried from the epididymis through the long, slender tube--the vas deferens--which connects the epididymis from each testicle with an ampulla. The ampullae are thickened areas of the vas deferens found high in the body cavity near the point where the two join the urethra. From the ampullae, sperm pass into the urethra, the common passageway for both semen and urine.

Near the point where the urethra and ampullae join are found the accessory glands called the seminal vesicles and the prostate. A short distance to the rear along the urethra is another pair of accessory glands, the Cowper's glands. Fluids from all of these accessory glands are added to the sperm from the testicles at the time of ejaculation. These fluids help transport the sperm, supply the proper environment to help keep the sperm alive, and even cleanse the urethra prior to the time that the sperm pass.

The urethra continues from high in the body (just below the rectum) through the penis to the exterior. Semen follows this path at the time of ejaculation. The penis of the bull, ram, and boar is constructed with an S-shaped curve in it. At the time of erection and mating, this S-shaped curve straightens out, thus enabling the penis to be extended to deposit semen in the vagina of the female.

5. Semen Collection, Processing, and Storing

Semen is an opaque, whitish fluid discharged by the male at the time of mating. There are considerable differences in individuals and species in semen volume

and sperm numbers. They are influenced by age, season of the year, general health, and sexual use. The ram is capable of repeated service without noticeable decline in volume and sperm concentration. In boars and stallions, service rates higher than twice daily usually affect semen quality.

Transparency No. 4

Semen characteristics may be expected to be equal to the species averages shown in this table.

The semen consists of a fluid part and a cellular part. The cells are the male reproductive cells or sperm cells and are produced by the testis. The fluid portion of the semen consists of secretions from the various glands in the reproductive tract of the male.

Transparency No. 5a

The sperm cells are microscopic in size and when observed under the microscope, they appear much like miniature tadpoles as they swim by their tails. Normal sperm consist of a head, a neck, a body, and a tail portion. The head in profile is flattened but, as seen under the microscope, is rounded or oval. It consists chiefly of nuclear material and is covered by a thin layer of cytoplasm. The head is of great importance because it contains the chromosomes (genetic materials).

The neck is very short and contains the anterior centrosome. The body is about the same length as the head. The movement of the sperm is brought about by the lashing of the tail.

Transparency No. 5b

Although there are minor differences in size, all spermatozoa are extremely small. A cow egg or ova has a diameter approximately 20 times greater than the length and 40 times greater than the width of the head of a bull sperm cell.

Transparency No. 6a

This illustration was taken from microphotographs of the sperm of a bull with a good breeding record. Cows bred to this bull required about 1.25 services per conception. Notice the uniformity and fullness of the heads. The tails appear normal, permitting vigorous motility of the sperm after it has been introduced into the female genitalia.

Transparency No. 6b

The second illustration shows sperm of a bull with a poor breeding record. The heads appear normal in size and shape, but it contains many sperm with coiled tails, and a few were tailless. Only a slight rate of movement was noted and some may have appeared to have been lifeless. This bull required over 3 services per conception when used on good breeding cows.

Transparency No. 6c

The third illustration shows semen from a bull with a questionable breeding record. The sample contained semen with about 25 per cent abnormal sperm. It had good motility and fair viability. The service ratio was about 2.5 services per conception.

a. Semen Collection

The method of collecting semen should be reasonably adapted to the males of the species, should be easy for the operator to use, and should permit the collection of a sample of normally ejaculated semen free from contamination with dirt, bacteria, or excess secretions from either male or the female genitalia.

(1) The Artificial Vagina

Many techniques have been developed for the collection of semen, but the most satisfactory one consists of using the artificial vagina, a Russian invention. Males usually respond to this method with little previous training. It is the most satisfactory method of collecting semen from the bull, stallion, or boar and may be used for the ram.

Transparency No. 7

An artificial vagina is made of two tubes--an outer one of heavy rubber and an inner lining of thin rubber. The space between the two tubes is filled with warm water. One end of the vagina is left open to permit the penis to enter. The other end leads to a graduated test tube into which the semen flows after ejaculation.

Best results are usually attained when the male is allowed to mount another animal and the penis is quickly diverted into the open end of the artificial vagina. If the vagina has been properly prepared, ejaculation is very shortly initiated.

Preparation of a bull for collection is important. A "teasing" period before collection, during which the bull may be permitted to mount

the teaser animal but not ejaculate, or may be restrained from mounting although he desires to do so, results in an improvement in the quantity and quality of semen produced. At collection, as the bull mounts a cow, a steer, or a dummy, his sheath is grasped and the penis quickly guided into the artificial vagina. If the proper technique, temperature (110° to 130° F), pressure, and lubrication have been observed, the bull will ejaculate immediately. The average semen volume per ejaculate is 8-10 cc., containing on the average 8 to 15 billion sperm.

The graduated test tube in which the semen has been collected from the artificial vagina is taken to the processing laboratory as soon as the collection is finished. The test tube itself indicates the volume of semen collected.

(2) Electrical Stimulation

Collecting semen by electrical stimulation has been used on rams for several years. Only since 1950, however, has the method been put to use with bulls. The use of the electro-ejaculator has overcome many of the difficulties experienced in using other methods for testing range bulls. If a bull is restrained properly in a good chute, semen can be collected with this machine regardless of the bull's disposition.

Transparency No. 8

The electro-ejaculator was developed to produce an electrical impulse to stimulate the nervous system supplying the reproductive tract, causing erection and ejaculation.

Electrodes are inserted into the rectum of the bull after the feces have been flushed out with a salt solution. Low-power stimulations given intermittently should be increased gradually to obtain extension and erection prior to ejaculation. The first fluid that passes is a clear, watery secretion from the accessory glands which contains few, if any, sperm cells. Following this, the ejaculate turns into a milky fluid consisting of sperm and accessory fluids. A collection is made at this time for evaluation. The collection is made in a test tube attached to a flexible plastic funnel which reduces breakage and injury. The reproductive organs should be examined for abnormalities at the time of testing.

(3) Massage of the Ampullae

This method requires a well-trained operator who inserts the hand into the rectum and massages the ampullae and accessory glands, causing semen to drip from the sheath. Semen collected by this method is of poor quality, because it may be contaminated with urine

and may contain too much accessory gland secretion for the number of sperm present. This system has been used successfully with bulls and stallions.

(4) Recovery of Semen from the Vagina

Natural service is first allowed. Then the semen in the anterior vagina is aspirated into a syringe by means of a glass or rubber catheter that is introduced into the vagina. Semen collected in this way is usually contaminated with the secretions of the female, and there is greater danger of spreading disease. Some operators prefer this method with sheep. It cannot be used with swine.

b. Semen Processing

(1) Testing of Semen

The thickness, or density, of the semen is tested in a photometer which estimates the number of sperm by means of a photoelectric cell.

Next, the semen is examined under a microscope. A drop of fresh semen is placed on a glass slide. The observer notes what percentage of the sperm in the sample move. If 80 per cent or more of the sperm move, the "percent motility" is excellent; 70 percent is good; 50 to 60 percent fair. Rapid forward movement is desirable.

Another characteristic to check for is the morphology or the appearance of abnormal sperm.

Semen samples may be examined with the naked eye to determine its quality, but with much less quality.

(2) Extending Semen

Millions of sperm are ejaculated by the male at the time of mating. In natural mating, all these sperm are used to breed one female, even though only one sperm of the millions fertilizes the egg. An ejaculation of the male can now be extended or diluted so that many more females can be bred with it. This is accomplished by adding materials to the semen which help to keep the sperm alive and at the same time give the sample more volume.

Transparency No. 9

The table shown in this transparency lists four most commonly used semen diluters and gives the classes of animal for which it is satisfactory.

- (a) Egg yolk - citrate
- (b) Egg yolk - phosphate
- (c) Homogenized whole milk
- (d) Glycine-containing diluents

Antibacterial agents are added to the extenders to help control bacterial growth. Antibacterial agents commonly used are:

Sulfanilamide - 3 milligrams per cc final diluent
Penicillin - 500 units per cc final diluent
Streptomycin - 500 micrograms per cc final diluent

In order to keep sperm alive, it is important that the diluents be added a few minutes after the semen is collected from the male. It is also important that sperm never be cooled suddenly. They can withstand slow cooling, but cold shock is extremely harmful. Thus, the semen and the diluent should always be near the same temperature.

Semen that is undiluted will not live much over 24 hours at room temperature. By adding diluents and slowly cooling the semen to refrigerator temperature, 41° F, the sperm may frequently be kept fertile for nearly a week, and active movement can be maintained for 20 to 30 days. The reduced temperature slows the sperm until it is inactive; thus its energy is saved.

c. Storing Semen

(1) Preparations for storage

After special treatment of semen with the selected extender, the sperm can withstand freezing to extremely low temperatures. Usually the semen is collected and diluted in the manner already discussed. After it is cooled, a 7 to 10% glycerol solution is added slowly over a one-half hour period. The sperm are then allowed to stand in the refrigerator for 6 to 18 hours.

(2) Ampuling

Transparency No. 10

The basic unit for semen storage and shipment is an individual glass ampule, containing just enough semen for a single insemination. After the semen has been collected and evaluated, glass ampules are prepared to receive the semen.

Each individual ampule is identified with the sire's name and registration number, breed, a code number, and identification as to the specific collection.

The filling and sealing operations are done in refrigerated rooms maintained at 40° F. Careful attention is given to the volume of semen in each ampule and to the quality of seal.

Table 1: Volume of Semen and Concentration per Insemination

Species	Semen Dilution Ratio	Volume of Semen Needed per Service	No. Sperm Per Insemination
Bull	1:200	*1 cc	15 million
Stallion	---	5-10 cc	250 million
Boar	1.8	50-100 cc	2 billion
Ram	1.1	*1 cc	50 million

*1 cc is the volume of semen contained in each ampule of bull and ram semen.

After filling and sealing, each ampule is clipped, one above another, to a metal holding device called a rack. This provision for vertical storage makes it possible to store many ampules of semen in a very compact space.

(3) Freezing and Storage

Finally, by using liquid nitrogen or dry ice in an alcohol bath, the diluted semen with the glycerol added is slowly frozen. When maintained at -110° F (dry ice) or -320° F (liquid nitrogen) until needed for breeding, semen will stay fertile and can be stored for months or perhaps years. It is important that the low storage temperature be maintained constantly; otherwise, the sperm will die.

The technician has the responsibility of handling the frozen semen in order to preserve its quality. Most technicians store the ampules of frozen semen in a liquid nitrogen container (refrigerator) such as the one illustrated. This particular liquid nitrogen container holds up to 480 ampules and may be safely stored for as long as 60 days.

6. The Function of the Female in Artificial Insemination

Transparency No. 11

The female mammal produces sex cells or eggs and furnishes a place within her body where these eggs, if fertilized, can grow and develop into young. The important parts of the female reproductive tract are the ovaries, oviducts or fallopian tubes, uterus, cervix, vagina, and vulva. (The function of these parts was discussed in the unit on "Palpation.")

The eggs produced by the ovaries of mammals are tiny structures which are very fragile. It has been estimated that an ordinary thimble, which would hold about 3 cc of fluid, would hold 2,000,000 cow eggs. Usually in the cow and mare, only one egg is released during each heat cycle. In the ewe, one or two and sometimes more are released. Many eggs are released in the sow at each heat and if they are fertilized by the male sperm, this results in litters being produced instead of only one or two young.

In addition to the egg-producing role, the ovaries play an important part in female reproduction by producing certain hormones which cause the female to be receptive to the male. This receptive period is called the heat or estrus period. Not only will the female accept the male at this time, but also this period usually marks the time when eggs are released from the ovaries.

7. Heat Detection and the Importance of Timing in Artificial Insemination

a. How to Find Cows in Heat

Successful, practical artificial insemination requires that a man's judgment be substituted for a bull's instinct. Should the man be less diligent or conscientious in the task of detecting cows in heat than a bull, the time when some cows are in heat will surely be missed, and they will pass out of heat un-inseminated.

Cows in heat are under the influence of a sudden, high-level occurrence of female sex or "heat" hormone (estrogen). The egg-containing follicle which produces the hormone, is at the height of its growth.

The nervous system is greatly affected. The cow is excitable and may do an unusual amount of bawling. She is restless and often walks the fences. The herdsman who knows his cows well can often recognize heat by the alert, bright-eyed, nervous appearance shown by cows during this period.

Cows in heat attempt to ride other cows. They stand to be mounted by other cows. Under conditions of natural service, they would stand and accept service by a bull. Standing is the only reliable, practical test for heat. When a cow stands she is in heat and is ready for service.

Ruffled hair over the tail head suggests that a cow has recently been ridden; she may or may not have been in heat. When cows "sniff around" one another, such is a common sign that one is approaching or is in early heat. Riding follows. Then--the cow in heat stands.

Many heifers and cows in heat flatten themselves down in the loin region. This presents a "sway back" and "high tail bend" appearance.

The heat hormone from the ovary also has an effect upon the genital organs. Genital mucous becomes greater in quantity and thinner in quality. It may

even flow from the vulva in long strings. Wet mucous smears are often noticeable on the buttocks, over the pin bones, and under the tail.

The vulva of a cow in heat appears somewhat swollen. The skin becomes more moist and less wrinkled. The fine hairs stick together because they are wet. The vulva of the cow when not in heat appears sunken. The skin is dry and in tiny folds and wrinkles.

The second or third day after heat, but sometimes earlier, bloody mucous passes from the cow's vulva. This may be noticed smeared on the buttocks or tail or, after lying down, in a pool behind the cow. Bleeding from the cow means that she has been in heat (ovulation implied) 2 or 3 days before. Whether a cow bleeds or does not bleed after heat has nothing to do with whether she has conceived or has not conceived from service or insemination at that heat.

Similar conditions to some of those described for finding cows in heat may be observed in other classes of farm animals.

b. Heat Detection Procedures

The herd management conditions determine the exact procedures to be followed in observing the individuals of a herd for signs of heat. This should be done at least twice each day. Animals in pasture must be carefully observed. A record-keeping system which tells when particular animals require watching helps in detecting females in heat. Adequate pens and holding facilities are very important in an A.I. Program.

c. The Importance of Timing in Artificial Insemination

It must be understood that the female is fertile only when an egg is present which can be fertilized. Likewise, it must be understood that an egg can live only a short time after being released from the ovary unless it is fertilized.

Transparency No. 12

The optimal time for insemination is in advance of the time of ovulation, which varies according to species.

Mares normally ovulate 24 to 48 hours before the termination of the heat period, cows about 10 to 12 hours after the end of heat, ewes near the end of heat, and sows about 30 to 40 hours after the beginning of the heat period. Thus, a mare with a 5-day heat period should be inseminated on the third day and at least every other day thereafter for the duration of heat. Cows should be inseminated during the latter half of the heat period, ewes during the last day of heat, and sows 12 to 24 hours after the beginning of heat. In sows, a second service 12 to 24 hours later increases conception and litter size.

Transparency No. 13

The following graph shows the percent of conception on first service and the best time to breed cows.

For highest conception rates in cattle, breed 60 to 90 days after last calving.

Best results will be obtained if cows are bred during the period of from 6 hours following beginning of true heat to 2 hours after the end of true heat.

Sperm will live about 24 hours in the female reproductive tract.

Sperm should be present in the female reproductive tract well before the egg is released.

True heat is demonstrated when the cow will stand to let other cows ride her.

Fertilization occurs immediately if sperm is present when the egg is released. If not, the egg may be fertilized during the next 6 to 10 hours.

8. The Insemination of the Female

Cleanliness during all insemination manipulations is essential and is the crucial point for success or failure. This applies to the instruments used, to the hands of the operator, and to the animals.

a. Prepare the Semen

- (1) Care should be taken in handling the semen ampules since exposure of frozen semen samples to air for over 20 seconds may lower the fertility of the semen.
- (2) Always wear gloves in handling frozen semen. The hazard of frostbite is not great, but it can happen. Some ampules, because of a faulty seal, explode rather violently and throw shattered glass in all directions.
- (3) Thaw water should be between 32° to 40° F (iced water), and the semen ampule should be put into the thaw water with not more than ten seconds exposure to air.

Frozen semen can be warmed rapidly without harm as long as the temperature does not rise above that of the body. There is less danger of cold shock when thawed in iced water, but thawing and holding ampules in ice water for several hours is not recommended.

b. Inseminating Technique

The procedures used in artificially inseminating female farm animals vary with the species involved. The cow and ewe have cervixes which are rather tightly closed. With these two, the cervix must be seen or grasped with the hand in order to insert the inseminating tube. In the mare and sow, the cervix is more open and will admit an inseminating tube more easily. In the smaller animals it is difficult or impossible to insert a gloved hand into the rectum to guide an inseminating tube. Thus, the sow with an open cervix can be inseminated simply by directing the tube into the vagina and carefully working it forward into the cervix. In the ewe, a speculum can be used to hold the walls of the vagina out so the opening of the cervix can be seen with a flashlight. The speculum method can be used on larger animals also.

(1) Artificial Insemination in Cattle

Transparency No. 14

The rectovaginal technique can be used with cows and mares. In this method, one hand covered with a rubber glove or disposable plastic glove-sleeve is inserted into the rectum. Most inseminators prefer to use the left hand for manipulation of the cervix through the rectal wall and the right hand for directing and controlling the inseminating tube.

The human hand working within the rectum must respect the physical makeup of the tissues and organs that are contacted. The technician must realize that serious damage will be done to the rectal wall, ovaries, or uterus when these structures are improperly handled.

Lubrication of the hand and arm is very helpful. Water is usually sufficient. A simple mild lubricant such as a K. Y. Jelly or equivalent, obtainable at most drug stores, may occasionally be necessary. Soaps or detergents are not recommended as lubricants since they are sometimes irritating and may be harmful to the sperm.

The technician's hand should be entered into the rectum by holding the fingers in a coned position and inserting the hand through the anal opening. The entire hand and as much of the arm as is needed can be passed into the rectal cavity. The cervix is located and then held and manipulated through the floor of the rectum. The other hand introduces the inseminating tube (pipette) 5 to 6 mm in diameter and 40 cm long, containing 1 m. (cc) of diluted semen, through the vagina. The hand within the rectum manipulates the cervix to permit the passing of the tube into the cervix.

In the cow, the semen is deposited in the cervix. The tube tip should not enter into the body of the uterus or the horns of the uterus, as it could damage the very fragile lining of that organ.

After passing the inseminating tube through the vagina and just through the cervix, depress the bulb slowly so that the semen does not adhere to the wall of the inseminating tube. Then withdraw the arm and hand slowly from the cow.

Results obtained by using the method on cattle have frequently been better than those obtained by natural mating. In natural service, the bull normally deposits the semen in the vagina next to the cervix, and the sperm apparently pass through the closed cervix with little difficulty. Presumably, contractions of the uterus, caused by the hormone oxytocin, are responsible for the quick transportation. It is believed that the sperm must be in the female reproductive tract for 4 to 6 hours to develop the capacity to fertilize an egg. Since sperm live for only about 24 hours in the female reproductive tract, the best time for insemination is between mid-heat and 6 hours after the end of heat. Breeding at this time enables the sperm to have the ability to fertilize the egg and remain in waiting in the oviduct for the egg to be released from the ovary.

Another important consideration in breeding cows is the time of rebreeding after calving. Too often the cow is given too little time to recover from the strain of carrying and delivering the previous calf. Careful studies have shown that at least 60 days should be allowed after calving before rebreeding. This is necessary to allow the reproductive tract of the cow to return to normal. When at least 60 days rest are allowed, the chances of getting the cow to conceive are better. Also, there is less chance of causing future breeding troubles.

(2) Artificial Insemination in Horses

There has been less interest in, and more resistance to, artificial insemination in horses than any other class of livestock.

Artificial insemination is not permitted by some horse breed registry associations but extensive use is made of the practice known as "impregnation." This consists of collecting the final portion of the ejaculate as the stallion dismounts and, with a syringe and inseminating tube, injecting it through the cervix of the mare just covered, with the object of increasing the chances of conception.

In the past, horse semen was considered to be extremely fragile and satisfactory results were thought to be obtainable only when it was used within a few minutes of collection. Now it can be stored effectively for up to 24 hours using egg yolk - glucose dilutors. It has also been successfully frozen. Normally the semen collected at one service from the stallion can be diluted to artificially breed about 15 mares.

For insemination, a glass syringe attached by a rubber adapter to a disposable inseminating tube is commonly used. The lubricated gloved hand containing the inseminating tube is passed into the vagina, the cervix located with the index finger, and the tube passed through the cervix. Insemination is thus made directly into the uterus. The optimum time for insemination can best be assessed by following the development of the follicle by rectal palpation. Another method is to estimate the time of ovulation from the appearance of the vagina and cervix as seen through a vaginal speculum.

It should be kept in mind that sperm are severely harmed by water, acids, soaps, metals, cold shock, and high temperatures. Thus, attempts should be made to avoid contamination of semen with any foreign materials, and careful temperature control should be maintained at all times.

(3) Artificial Insemination in Sheep

Except in Russia, the technique of artificial insemination of sheep has not passed much beyond the experimental stage. It has not found wide application in the sheep industry in the United States because the demand for it has not yet arisen. Until the problem of storage is solved, it will be necessary that semen be collected from rams when and where it is to be used.

Ewes in heat are identified by vasectomized rams carrying some suitable "marker" device on the brisket. Preferably, ewes should be inseminated during the latter half of the heat period and while the vaginal mucous is thin and clear in appearance.

For insemination, the ewe is restrained to limit movement and to present the hindquarters at a convenient height for easy access to the vagina. The cervix is located with the aid of a speculum and suitable light, and the insemination is made as deeply as possible into the cervical canal. In inseminating ewes 0.05 to 0.2 cc diluted semen containing 50 to 100 million sperm is recommended for deposition in the cervix.

(4) Artificial Insemination in Swine

Artificial insemination of swine is still in the experimental stage in the United States, but there is great interest in its potential. The techniques involved have been developed to the point where artificial insemination is reliable and technically simple.

In sows, ovulation occurs normally about 40 hours after the onset of heat. The optimum time for insemination occurs about 16 hours before ovulation and coincides with the time during heat when most gilts and sows will tolerate heavy pressure on the loin area. Inseminations performed at this time will result in a farrowing rate of about 75%, while inseminations at other times result in 30 to 40% conception rate.

At insemination a disposable plastic pipette is inserted into the cervix, keeping the pipette against the dorsal surface of the vagina. The semen is slowly forced into the uterus from a plastic squeeze or syringe. In swine, 20 to 50 cc of fresh semen diluted at a rate of 1 part of semen to 1.5 to 5 parts of diluent has given reasonable conception rates. Careful heat checks and patience during insemination are essential for good results.

9. Animal Health and Sanitary Precautions

Transparency No. 15a

Based on present knowledge gained through research and practical observation, it may be concluded that stockmen can make artificial insemination more successful by observing the following:

a. Animal Health

- (1) Don't breed back too soon. In cows, wait 60 days before rebreeding. Mares may be bred back on foal heat (7 to 11 days after foaling), provided foaling was normal and no infection occurred; otherwise, wait 25 to 30 days. Sows should be bred back in 35 to 49 days. Ewes are normally bred to lamb at a specific season depending on the market situation and are not bred back immediately after lambing.
- (2) Avoid breeding diseased females or females showing infectious discharges.
- (3) Have males inspected at regular intervals by a competent veterinarian and pronounced free of transmissible diseases.
- (4) Have females examined that have been bred three times without conception or that show other reproductive abnormalities.

- (5) Keep records of heat periods and note irregularities.

b. Sanitary Precautions

Transparency No. 15b

- (1) All semen collection equipment should be clean and sterile.
- (2) All glassware with which semen is to come in contact should be clean and sterile.
- (3) Follow strict refrigeration recommendations for handling semen both after collection and before insemination.
- (4) The inseminator-technician should make certain that all equipment used in the insemination process is completely sterilized.
- (5) Disposable equipment such as plastic sleeves, plastic inseminating tubes, etc. should be placed in a suitable receptacle to avoid possible contamination of other animals on the farm.

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6. Rice, Victor A., Frederick N. Andrews, and others, Breeding and Improvement of Farm Animals, McGraw-Hill Book Company, New York.
7. Testing Bulls for Fertility, Bulletin 924, Texas Agricultural Experiment Station - Texas Agricultural Extension Service, Texas A&M University, College Station, Texas.

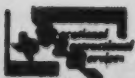
WHY BREED ARTIFICIALLY ?

- A. MAXIMUM USE OF OUTSTANDING SIRES
- B. GREATLY INCREASED UNIFORMITY
- C. POSSIBLE TO OVERCOME CERTAIN PHYSICAL HANDICAPS TO MATING
- D. LESSENS SIRE COST
- E. ALLEVIATES DANGER AND BOTHER OF KEEPING A SIRE
- F. REDUCES THE COST AND DELAYS OF USING INFERTILE SIRES
- G. BETTER HEALTH PROTECTION
- H. IMPROVED HERD RECORDS
- I. INCREASES PROFITS
- J. INCREASES PRIDE OF OWNERSHIP

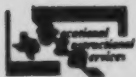
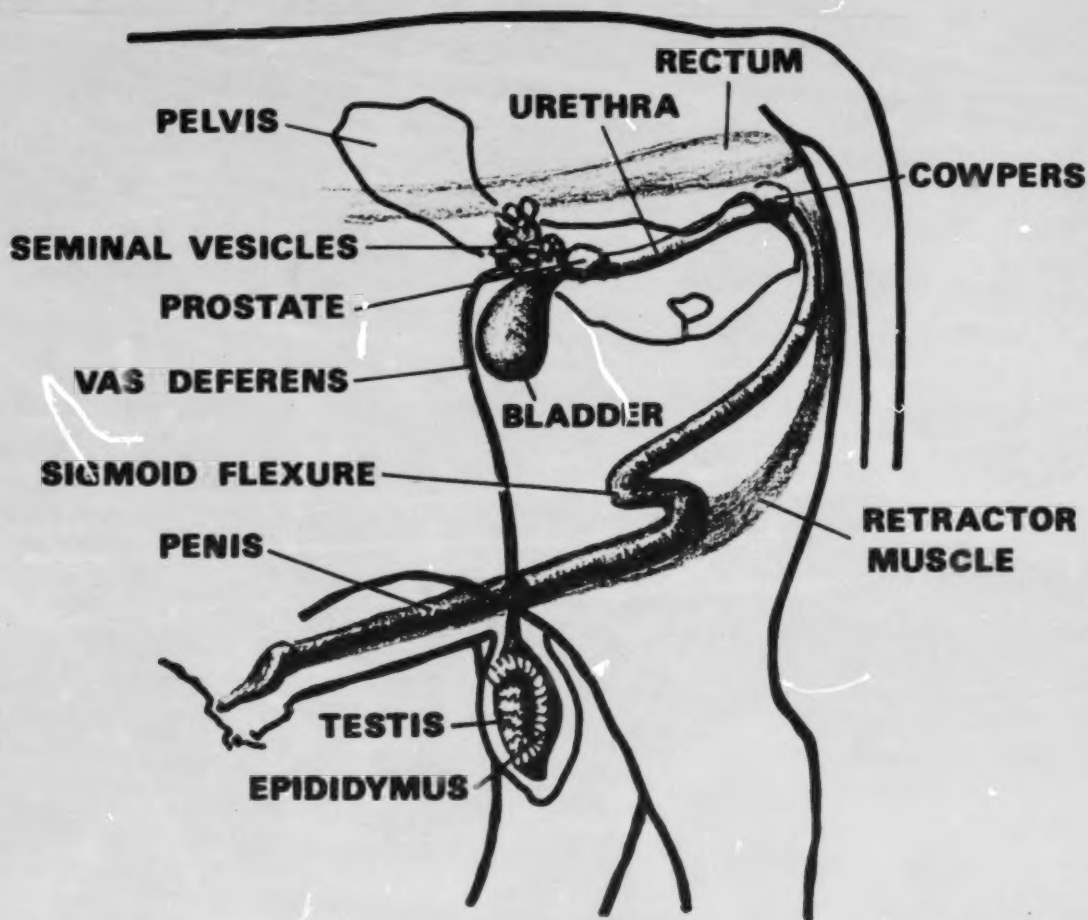


LIMITATIONS OF ARTIFICIAL INSEMINATION

- A. REQUIRE SKILLED TECHNICIAN**
- B. MUST CONFORM TO PHYSIOLOGICAL PRINCIPLES**
- C. MAY RESTRICT THE SIRE MARKET**
- D. MAY INCREASE THE SPREAD OF DISEASE**
- E. MAY BE SUBJECT TO CERTAIN ABUSES**
- F. MAY ACCENTUATE THE DAMAGE OF A POOR SIRE**
- G. CONSIDERABLE CAPITAL AND COMPETENT MANAGERIAL ABILITY ARE NECESSARY TO INITIATE AND OPERATE AN ARTIFICIAL BREEDING ORGANIZATION**



MALE REPRODUCTIVE TRACT

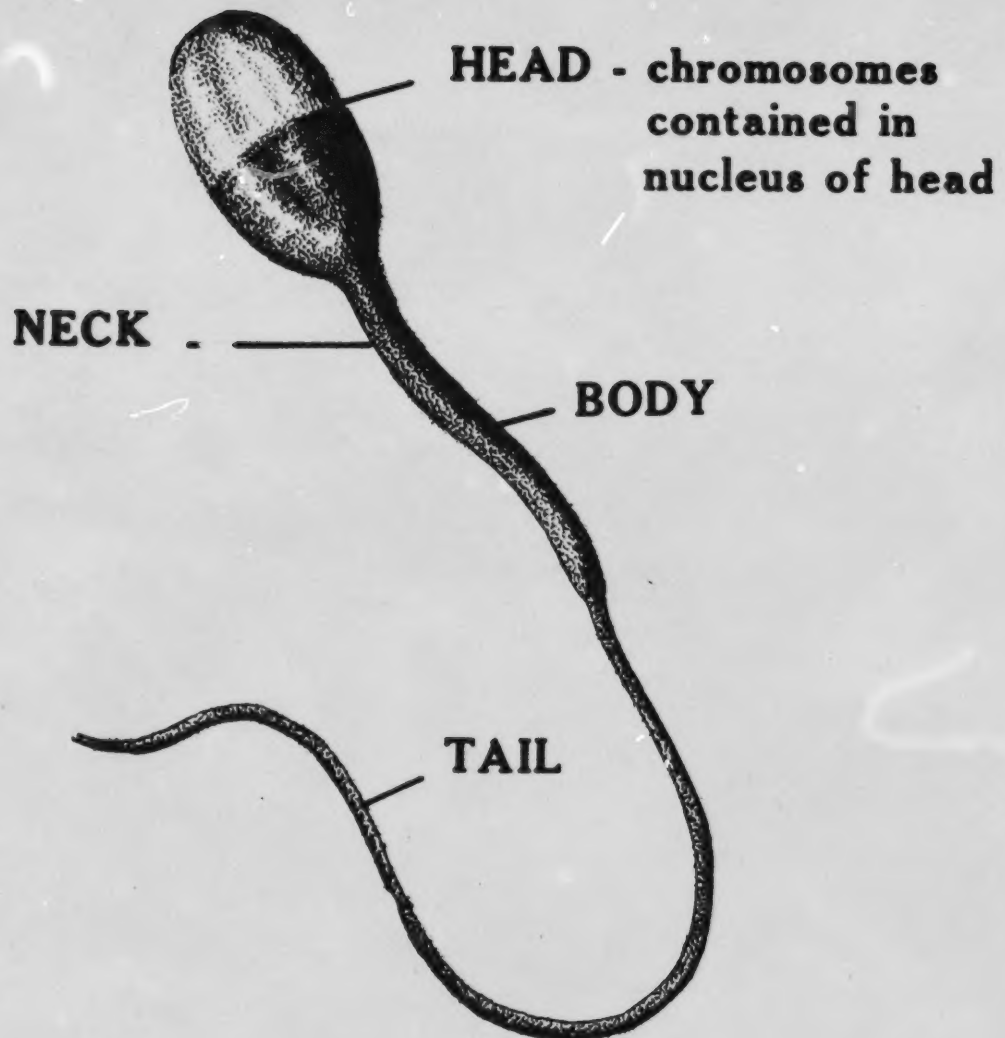


SEMEN VOLUME & NUMBERS FOR FARM ANIMAL SPECIES

Animal	Vol. per Ejaculate (ml.)	Sperm per mm. (1,000's)	Total Sperm per Ejaculate (billions)
boar	150-250	100	15-25
bull	4-7	1,000	3-5
rooster	0.6-0.8	3,000	1.8-2.4
ram	0.8-1.0	1,000	0.8-1.0
stallion	70-100	100	7-10
	No. Females Bred per Ejaculate		
	boar	10-12	
	bull	100-600	
	rooster		
	ram	40-100	
	stallion	8-12	



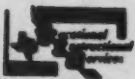
ANATOMY OF SPERM



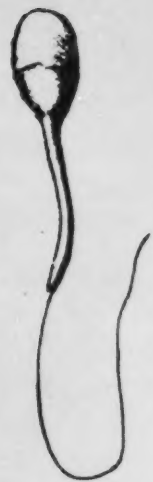
145

V.A.III

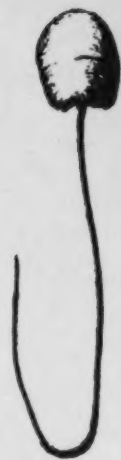
II-A-8
No. 5a



SPECIES DIFFERENCES IN SPERM ANATOMY



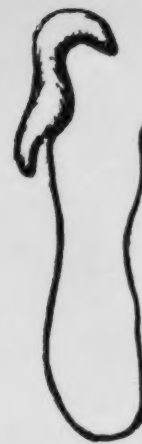
BULL



SHEEP



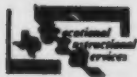
CHICKEN



RAT



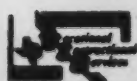
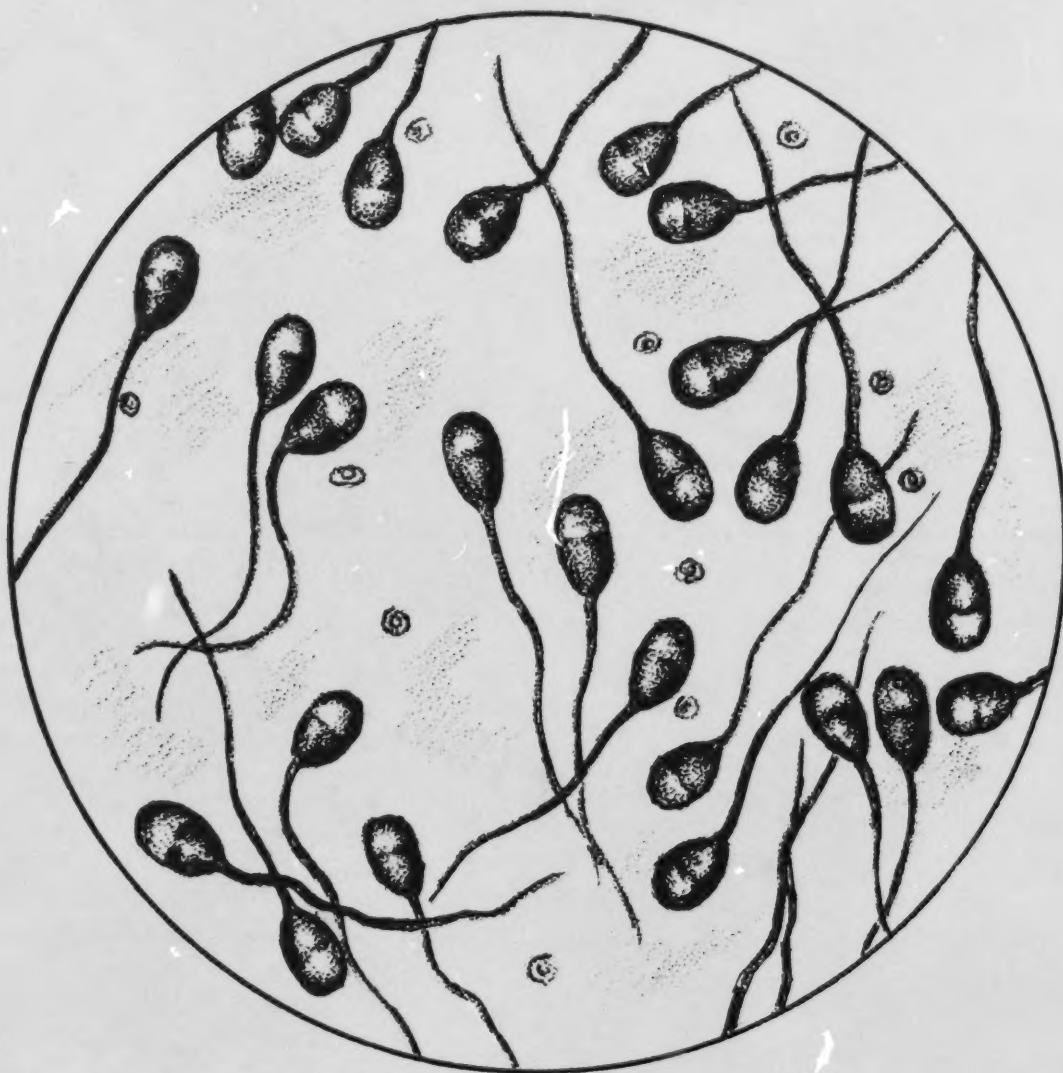
GUINEA PIG



V.A.III

II-A-8
No. 5b

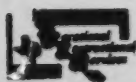
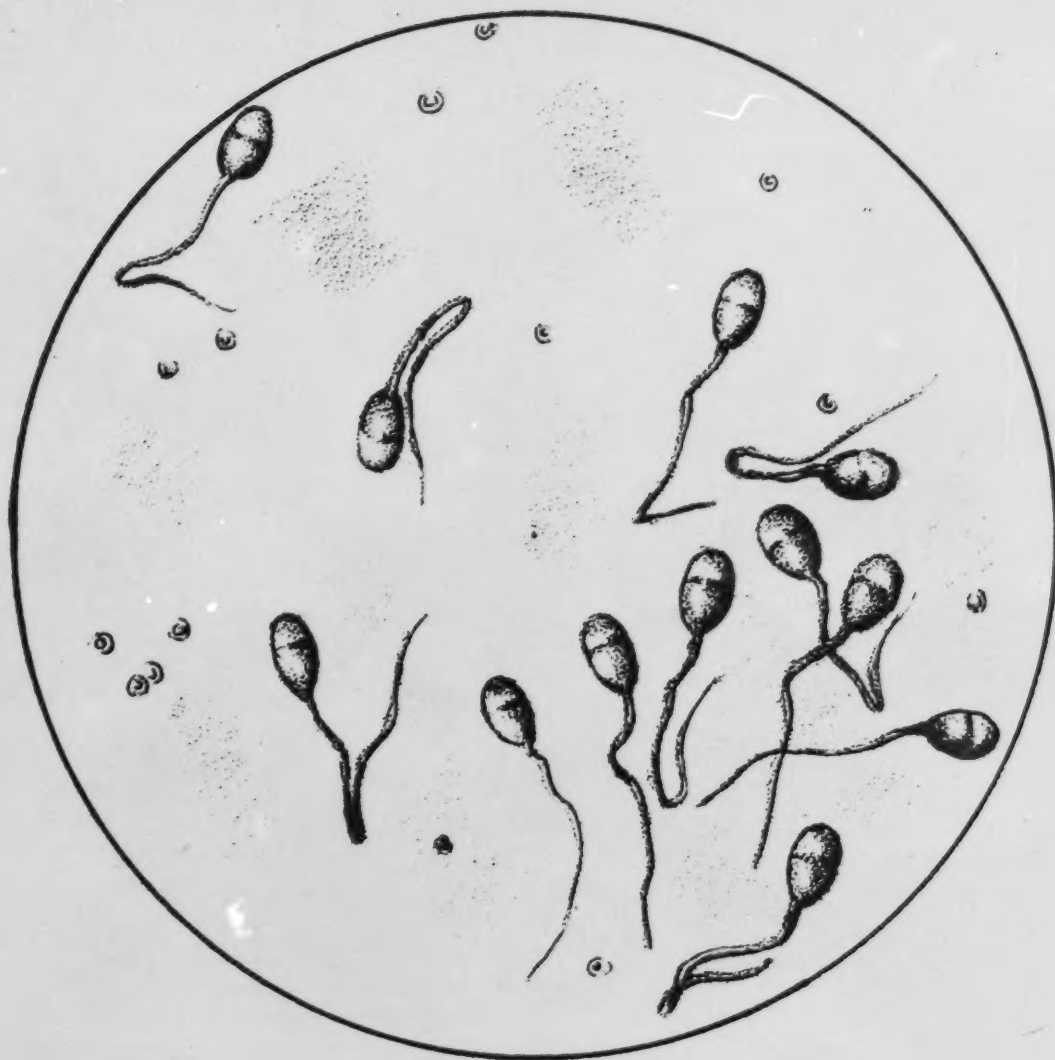
GOOD SEMEN



V.A.III

II-A-8
No. 6a

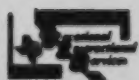
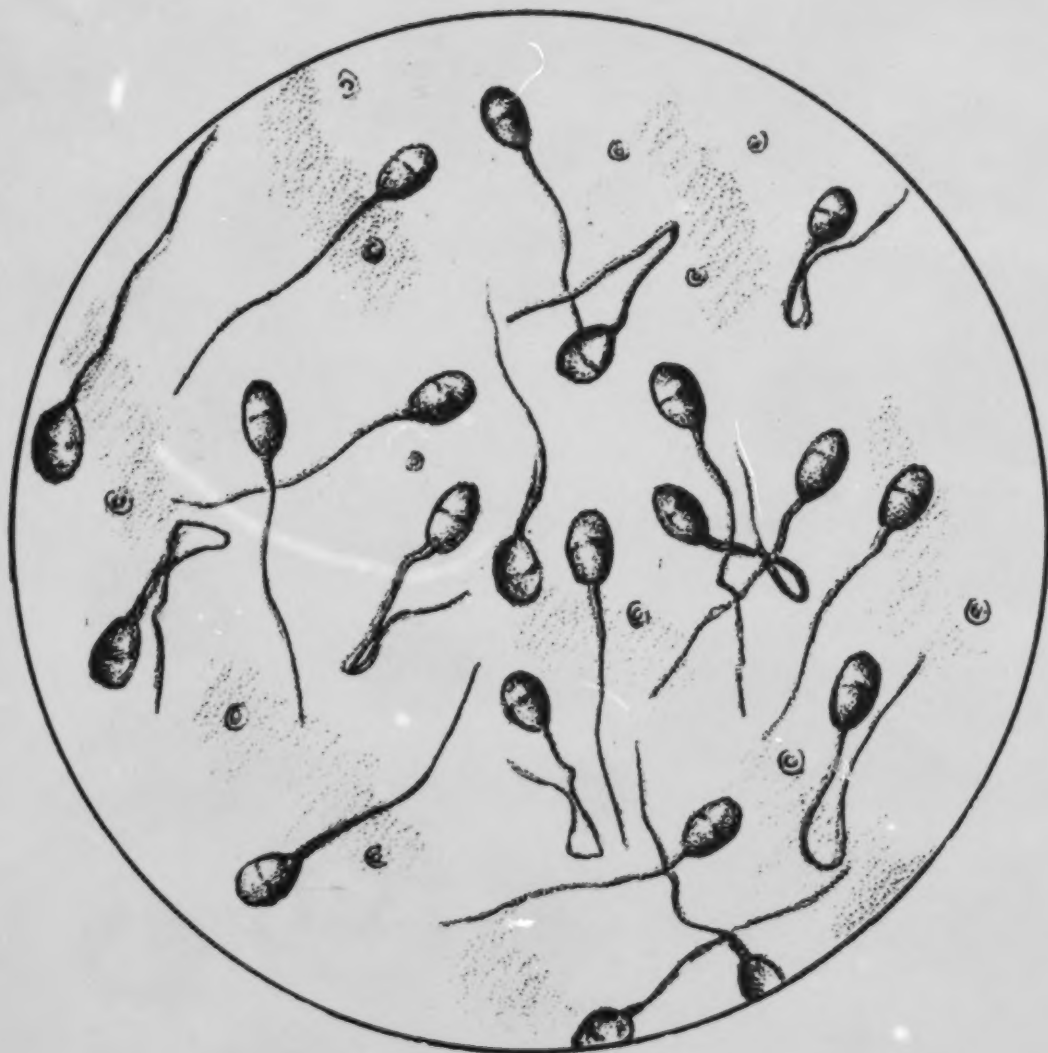
POOR SEMEN



V.A.III

II-A-8
No. 6b

QUESTIONABLE SEMEN

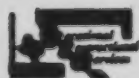
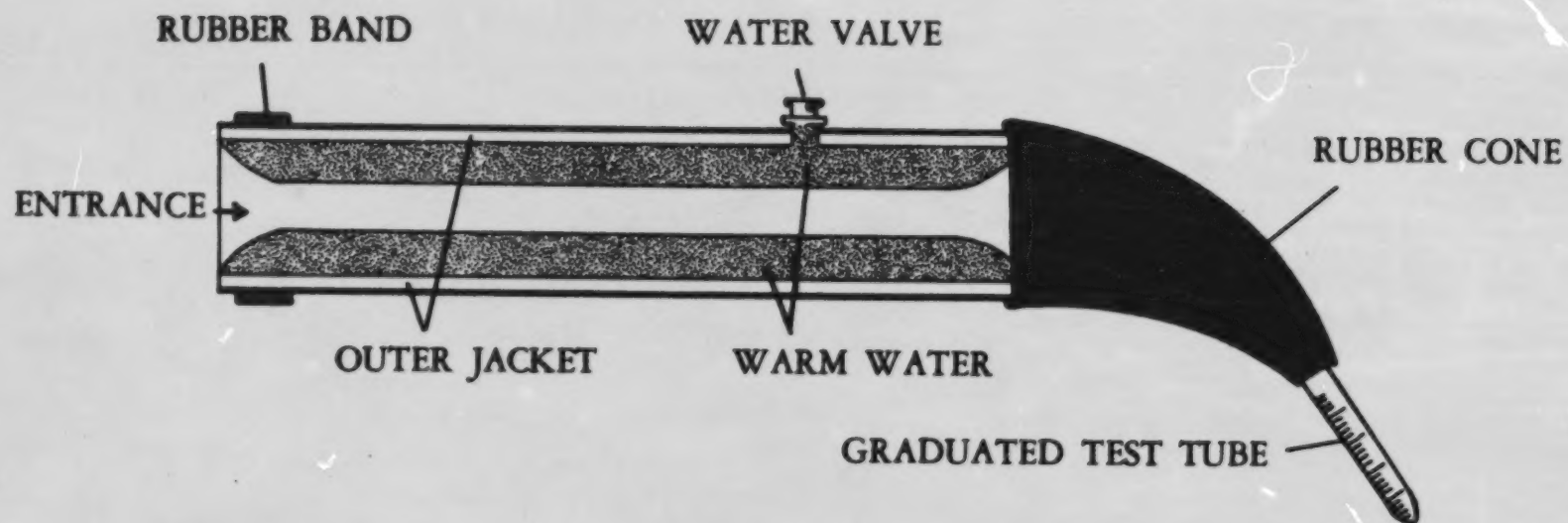


V.A. III

150

II-A-8
No. 6c

ARTIFICIAL VAGINA



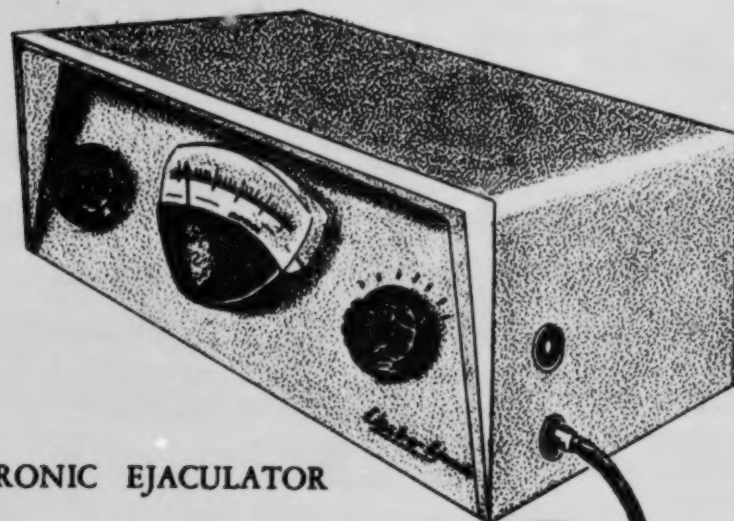
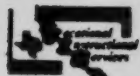
V.A. III

II-A-8
No. 7

ELECTRONIC SEMEN COLLECTION EQUIPMENT



COLLECTION HANDLE
AND VIAL



ELECTRONIC EJACULATOR



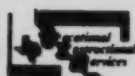
PROBE

V.A. III

II-A-8
No. 8

SEMEN DILUTERS

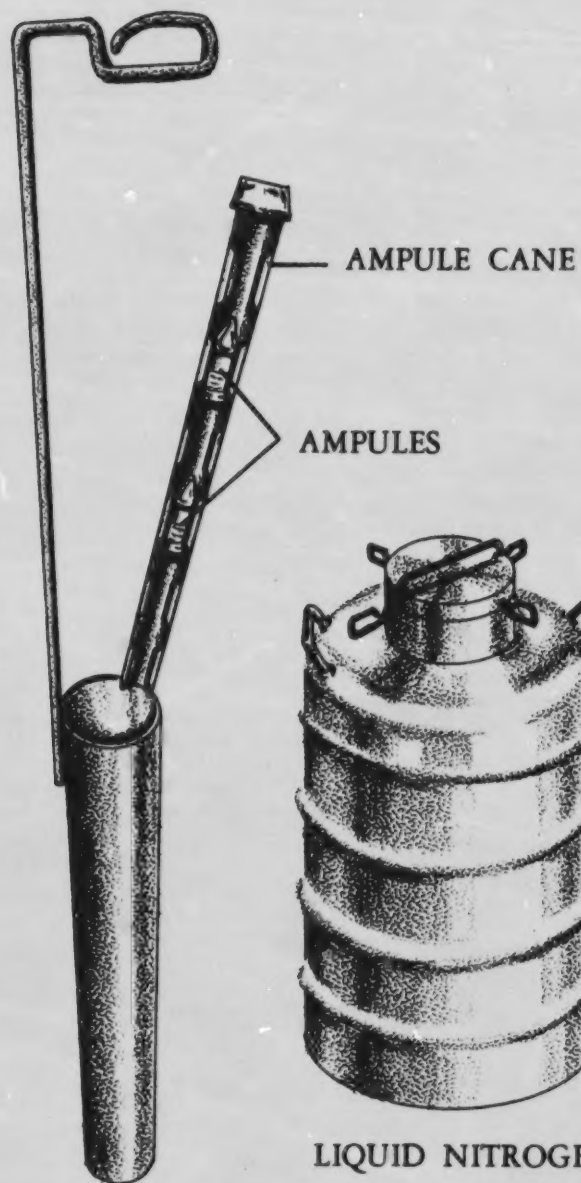
Type of Diluter	Classes of Animals Used For	Comments
1. egg yolk-citrate	bull, ram	1 part fresh egg yolk to 3 parts 2.9% sodium citrate dihydrate in distilled water.
2. egg yolk-phosphate	bull, ram, stallion	mix equal parts of fresh egg yolk and chemically pure sodium hydrophosphate-hydrate or (appropriate phosphate solution)
3. homogenized whole milk	bull, ram, boar	boil fresh homogenized whole milk for 5 to 10 minutes. then cool to body temperature and dilute with equal parts of distilled water.
4. glycine-containing diluents	boar	formula-50% of a 4% glycine solution, 42.5% skim milk, and 7.5% egg yolk



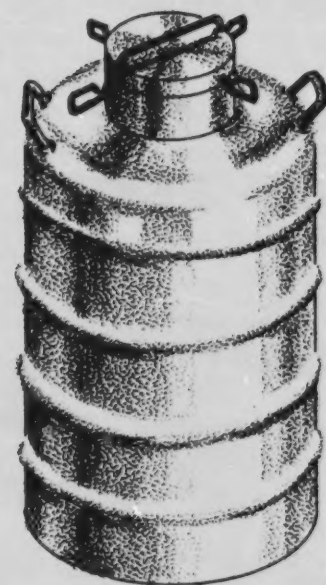
SEMEN AMPULING AND STORAGE



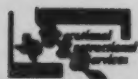
SEMEN AMPULE



CANISTER

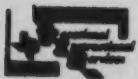
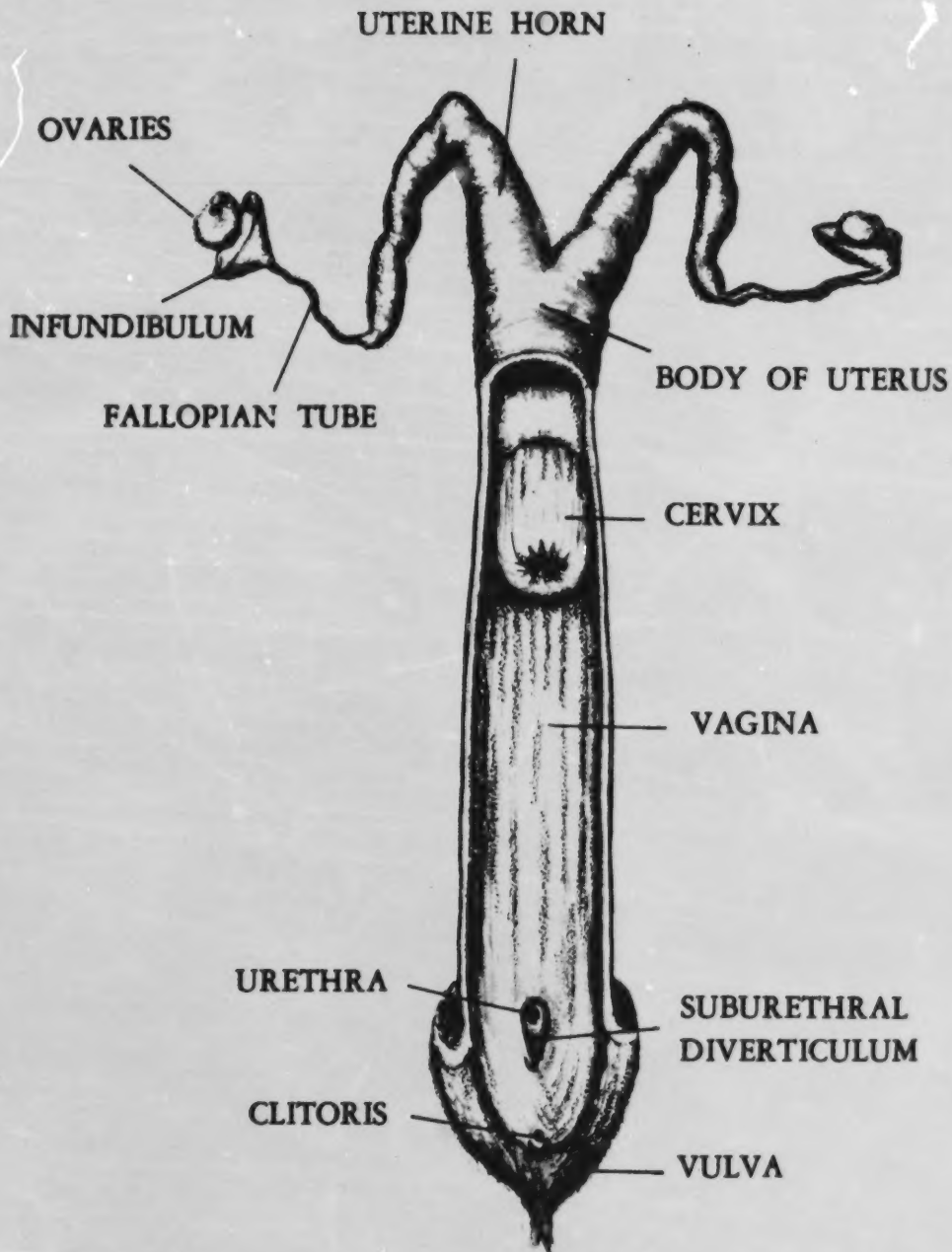


LIQUID NITROGEN
STORAGE CONTAINER



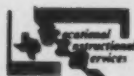
FEMALE REPRODUCTIVE TRACT

(top view)

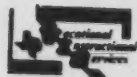
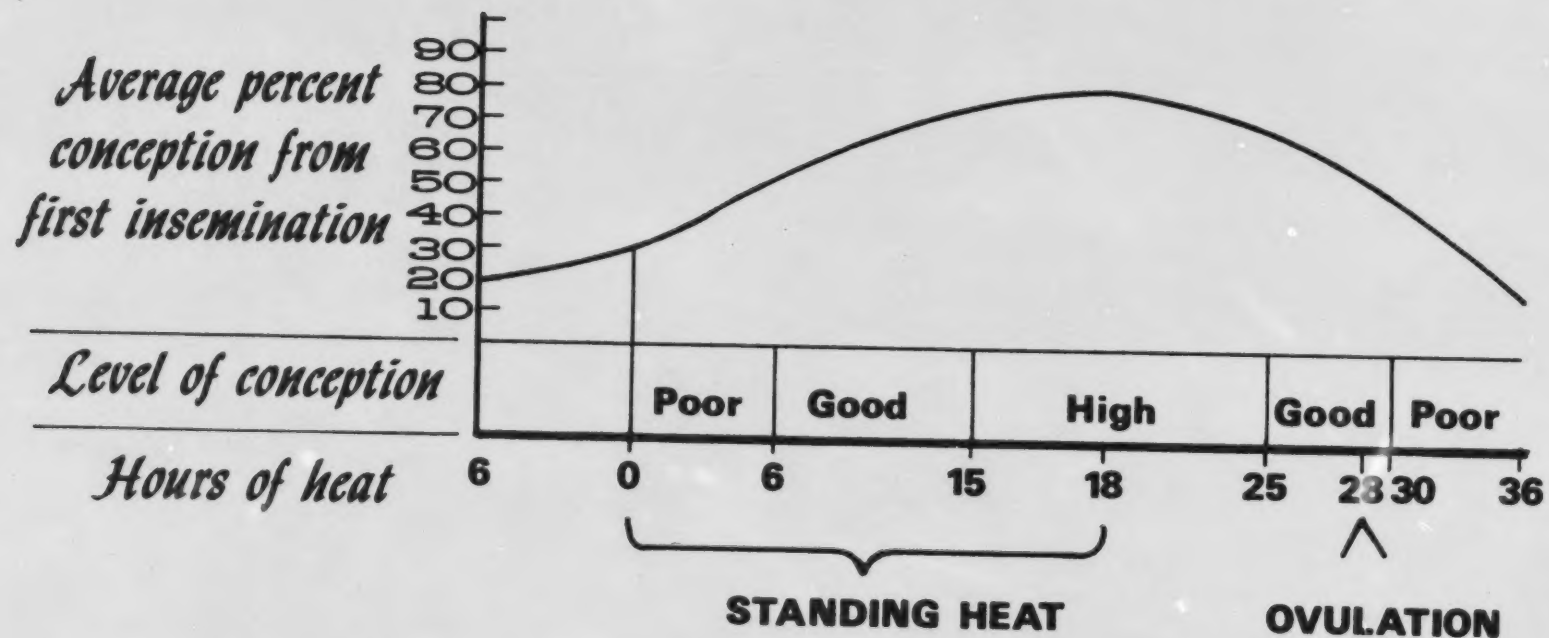


THE REPRODUCTION CYCLE IN FARM ANIMALS

Species	Length of Estrus Cycle (days)		Length of Estrus		Usual Time of Ovulation	Length of Gestation (days)		Age at Puberty (months)
	av.	range	av.	range		av.	range	
mare	21	10-37	5-6 days	1-14 days	24-48 hrs. before end of estrus	336	310-350	10-12
cow	19-21	16-24	16-20 hrs.	8-30 hrs.	10-14 hrs. after end of estrus	281	274-291	4-8
ewe	16	14-20	30 hrs.	20-42 hrs.	1 hr. before end of estrus	150	140-160	4-8
sow	21	18-24	1-5 days	1-5 days	18-60 hrs. after estrus begins	112	111-115	5-7



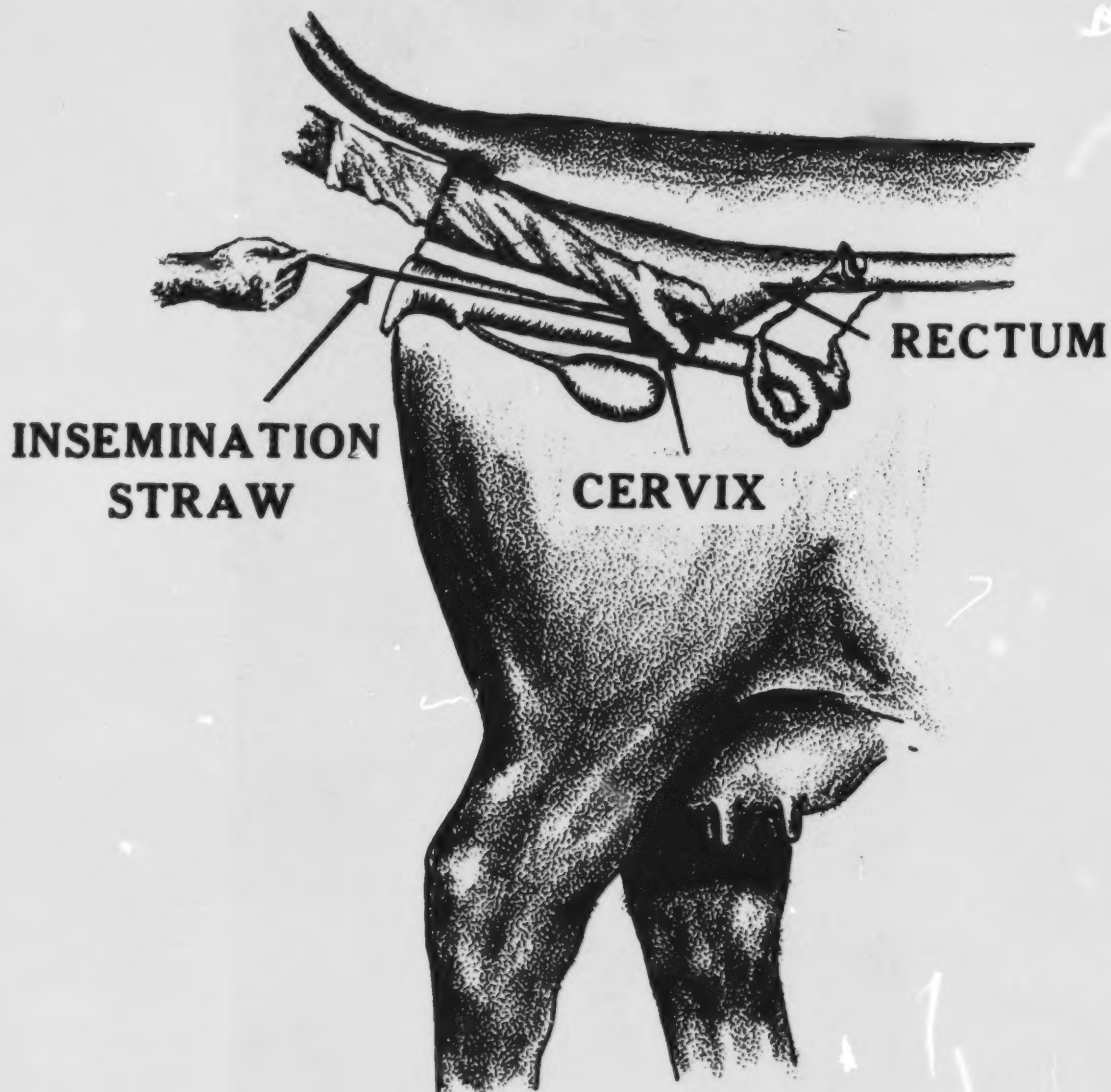
TIME OF BREEDING AND CONCEPTION RATE IN CATTLE



V. A. III

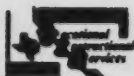
II-A-8
No. 13

ARTIFICIAL INSEMINATION



ANIMAL HEALTH PRECAUTIONS IN ARTIFICIAL INSEMINATION

- 1. DON'T BREED BACK TOO SOON**
- 2. AVOID BREEDING DISEASED FEMALES**
- 3. HAVE MALES INSPECTED AT REGULAR INTERVALS**
- 4. HAVE FEMALES INSPECTED THAT HAVE NOT
CONCEIVED AFTER THREE BREEDINGS**
- 5. KEEP RECORDS OF HEAT PERIODS AND NOTE
IRREGULARITIES**

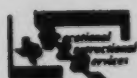


V.A.III

II-A-8
No. 15a

SANITARY PRECAUTIONS IN ARTIFICIAL INSEMINATION

- 1. STERILIZE ALL SEMEN COLLECTION EQUIPMENT**
- 2. CLEAN AND STERILIZE ALL GLASSWARE FOR
SEMEN HANDLING**
- 3. FOLLOW STRICT REFRIGERATION REGULATIONS
FOR HANDLING SEMEN**
- 4. COMPLETELY STERILIZE ALL INSEMINATION
EQUIPMENT**
- 5. MAKE PROPER DISPOSAL OF ALL DISPOSABLE
EQUIPMENT**



ANIMAL SCIENCE

Unit B: Livestock

Topic 1: Carcass Evaluation

Note: All terms underlined are included in the "Glossary of Terms."

Several methods may be used to evaluate livestock carcasses, but the most accurate method is through the use and application of the USDA Official Standards for the different species and classes of livestock carcasses. Since the evaluation of beef, swine, and sheep carcasses, using the official standards as a basis, are discussed in detail in the V.A.II materials, Topic II-E-2, this topic will be concerned with the establishment of the official standards, how the U.S. grades may be used by consumers and the packing and processing industries, and the purposes and benefits of meat inspection.

1. Introduction

During World War I, the armed services used tentative grade standards in the purchasing of beef. In 1925, the Sixty-eighth Congress established the Federal Meat Grading Service; however, it was 1926 before the first official beef grading standards were adopted. Official standards were adopted for lamb and written in 1931, and tentative standards were adopted for pork in the same year.

The official standards for all species and classes of livestock carcasses and wholesale cuts have been revised several times. Changes in the quality of meat demanded by consumers and in the type of animal produced are usually the reasons standards are revised.

Federal grades provide the consumer with a reliable guide to quality. Each grade has specifications which must be met in order for the carcass to receive that grade stamp. The standards also specify that a carcass must have a certain degree of quality. Quality refers to tenderness, juiciness, and flavor. Meats of different quality must be prepared differently. The grade indicates to the knowledgeable consumer the manner in which the meat should be prepared. The grade stamp that appears on meat, therefore, can be used in two ways by the consumer: (1) as a quality guide, and (2) as a guide for preparation. All grades of meat can be made appetizing if properly prepared.

Consumers must be familiar with the quality of each grade to take advantage of the difference in quality among the grades. There is some variation in quality between the grades and a considerable difference from the top to the bottom grade in a particular class.

The Agricultural Marketing Service, U.S. Department of Agriculture, administers the federal grading of meat. Federal graders are of high integrity, must complete an intensive training program, and receive Civil Service Commission appointments after being employed. The firm (slaughter plant) requesting the grading service is charged for this service.

The meat grader can be identified by the stamp used. Letters of the alphabet appearing on the grader's stamp form a code, which is used as an identification. A roller stamp is used to apply the grade. The stamp is rolled the full length of the carcass, or of the wholesale cuts if they are being graded.

Most livestock carcasses are sold on a nongraded basis; however, the number of carcasses being federally graded are increasing. With the exception of poultry, it is expected that more beef is graded than other kind of meat. However, during the first seven months of 1975, only 41 percent of the beef produced was actually graded. Of the beef graded during this period, 96 percent graded either Prime, Choice, or Good. This indicates that most of the graded carcasses were from fed beef.

Much of the meat produced by the lower grades is used as ground meat for hamburger, or in a mixture of prepared meats, such as sausage. There are not any advantages in the grading of the carcasses that supply the meat for these products.

2. Meat Inspection

The purpose of inspecting meat and slaughtering plants is to make sure the meat is wholesome and fit for human consumption. Slaughtering plants are inspected periodically to make sure they are handling meats properly and the plant and facilities are clean and sanitary.

Prior to the passage of the Meat Inspection Act on June 30, 1906, inspection was conducted only on cattle and hog carcasses intended for export. The original Act has undergone improvements over the years. The Wholesome Meat Act of 1967 is a recent revision. Included in the Act was the stipulation that states must establish meat inspection systems equal to the Federal system. Before the enactment of the 1967 Act, Federal inspection applied only to meat and meat products in interstate or foreign commerce. Meat inspection systems among the states varied, and some states did not have a meat inspection system.

States were given until December 15, 1970 to initiate a system and train inspectors; otherwise, Federal inspection would take over meat inspection within the state. Some states complied with the Act, while in other states the Federal system and inspectors are being used. The Animal and Plant Health Inspection Service (APHIS), U.S. Department of Agriculture, is responsible for the Federal inspection of meat, poultry, and plants processing foods.

To comply with the Wholesome Meat Act, 500 people in Texas were trained and employed to inspect slaughtering plants. In 1971, there were 748 plants being inspected in the state.

Exemptions were provided in the Act for individuals having animals slaughtered for use by their family and guests. Processors are allowed to slaughter animals for individuals; however, the meat must be kept separate from the carcasses slaughtered for retail sales.

Transparency No. 1

Functions of the Federal inspection system are shown in the above transparency.

Transparency No. 2

Meats passing inspection are stamped with an inspection stamp. The stamp has an abbreviated form of "U.S. Inspected and Passed" and a number on it. The number is assigned to only one slaughter plant. Since the stamp appears only on the whole-sale cuts, the consumer will not be able to observe the stamp on retail cuts.

A fluid consisting of harmless vegetable coloring is used for stamping meat. The same fluid is used to apply the quality and yield grades and packer brands to carcasses and wholesale cuts.

A prepackaged label is placed on all Federally inspected meats or items containing meat products. This includes soups and spreads.

A mark, label, or metal tag is placed on fresh and frozen processed poultry products.

State inspection stamps are similar to the Federal stamp. It also has an abbreviated form of "Inspected and Passed," a number which is assigned to a specific plant, and the words or an abbreviation of the words, "Department of Agriculture."

Another important function of the Federal Meat Grading Service is the Meat Acceptance Service, a service provided organizations (private institutions, meat purveyors, and governmental organizations). The Meat Acceptance Service provides two services: (1) development of specifications for meat purchases and (2) the actual examination of meat and meat products for compliance with the specifications.

Specifications are available for a large number of items. Copies of the specifications may be purchased from the Government Printing Office.

To use the Meat Acceptance Service, the purchaser requests suppliers to submit bids on a product (s) based on IMP specifications. The supplier receiving the contract contacts a Federal meat grader and requests an examination of the products. The grader is responsible for accepting the products and certifies that they meet specifications. Each item or carton is stamped with a Meat Acceptance Service stamp, and the purchaser is provided with an official certificate containing information about the product. Procuring meat by this method assures the purchaser or firm that the grade, trim, and weight specified is adhered to.

3. Uniform Retail Meat Identity Standards

Transparency No. 3

With the assistance of the White House Office of Consumer Affairs, USDA, and Council of Better Business Bureaus, a committee composed of retail grocers, meat packers, and others was formed for the purpose of standardizing retail meat cuts and their names over the entire U.S. Uniform Retail Meat Identity Standards for the cutting and labeling of meat were established, and many grocery firms are following the standards. A sample label used by a retail grocery firm is shown in the above transparency.

4. Federal Grades, Packer Brands, And Aging of Meats

Transparency No. 4

Both quality and yield grades appear on all graded beef carcasses and wholesale cuts. Examples of the stamps are shown in the above transparency. The quality and yield grade stamps for other kinds of livestock carcasses are similar to the ones shown for beef.

Much of the pork, especially those cuts that are cured, are given a packer brand. The packing firm establishes quality standards which the product must meet before it may carry the packer's brand. Products not meeting the standards are sold as nongraded. Packer brands are usually reliable indicators of quality.

Aging

Only high quality ribs and loins of beef and lamb are generally aged. However, some individuals have the entire carcass aged, especially when slaughtered by a custom slaughterer.

Meats are aged to further develop their tenderness and to give them a characteristic flavor. The meat must have a thick covering of fat in order to be aged. Fat covering prevents the lean from becoming discolored and keeps evaporation to a minimum. The most widely used methods of aging are as follows:

1. Vacuum packaging - The meat is placed in a moisture proof film and kept in the film until it reaches the customer. Weight losses due to moisture evaporation and surface spoilage are reduced by this method. The meat is kept in the package for two to three weeks.
2. Fast aging - The meat is held at a temperature of about 75 degrees F. and a humidity of 85 to 90 percent for one or two days when this method is used. The meat is placed under an ultraviolet light to reduce the microbial population.

3. Dry aging - The meat is stored for three to six weeks at a temperature of 34 to 38 degrees F. The humidity in which the meat is stored varies with the processor. Some prefer a relatively low humidity for storage, while others want the humidity to be 85 to 95 percent. The higher humidity increases mold development on the outer surface and reduces moisture losses in the meat.

References:

1. Romans, John R., and P. Thomas Ziegler, The Meat We Eat, The Interstate Printers and Publishers, Inc., Danville, Illinois.
2. Levie, Albert, The Meat Handbook, The AVI Publishing Company, Inc., Westport, Connecticut.

FUNCTIONS OF FEDERAL INSPECTION SYSTEMS

- * INSPECTION OF MEAT AND POULTRY SELLING IN INTERSTATE AND FOREIGN COMMERCE**
- * INSPECTION OF ALL MEAT AND POULTRY PRODUCTS AND SLAUGHTERING PLANTS IN STATES NOT HAVING AN INSPECTION SYSTEM COMPARABLE TO THE FEDERAL SYSTEM**
- * REVIEW OF STATE PROGRAMS TO MAKE SURE STATES MAINTAIN PROGRAMS**
- * REVIEW FOREIGN INSPECTION SYSTEMS AND PACKING PLANTS THAT SHIP MEAT, POULTRY, AND THEIR PRODUCTS INTO THE U.S.**
- * INSPECTION OF PLANT FACILITIES, EQUIPMENT, SANITATION, SLAUGHTER, METHODS OF PROCESSING, AND CONTAINERS AND LABELING**

STAMPS USED BY INSPECTORS



INSPECTION STAMP



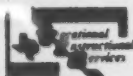
PRE-PACKAGE LABEL



**FRESH OR FROZEN
POULTRY MARK**



**MEAT ACCEPTANCE
SERVICE STAMP**



LABEL USED BY GROCERY FIRMS (RETAIL MEAT IDENTITY STANDARDS)

FIRM NAME

FIRM LOGO

**WEIGHT - POUNDS
AND HUNDREDTHS
OF POUNDS**

TOTAL PRICE

DATE PACKED

HUNGRY PEOPLE FOOD, INC.

Hp food

QUALITY MEATS

**WEIGHT
LBS. NET
0.00**

**THIS PACKAGE
0.00**

**PRICE
PER LB
0.00**

PRICE PER POUND

**BEEF CHUCK
BLADE ROAST**

KIND OF MEAT

**RETAIL CUT - DESIGNATES WHAT PART
OF THE PRIMAL CUT THE CUT COMES
FROM**

**PRIMAL (WHOLESALE) CUT - CHUCK,
RIB, LOIN, ROUND, ETC. - TELLS
WHERE THE CUT COMES FROM
ON THE CARCASS**

QUALITY AND YIELD GRADE STAMPS



FEDERAL GRADES FOR BEEF, VEAL, LAMB AND PORK CARCASSES

BEEF		VEAL	LAMB	PORK
<u>Quality</u>	<u>Yield</u>			
PRIME	NO. 1	PRIME	PRIME	U.S. NO. 1
CHOICE	NO. 2	CHOICE	CHOICE	U.S. NO. 2
GOOD	NO. 3	GOOD	GOOD	U.S. NO. 3
STANDARD	NO. 4	STANDARD	UTILITY	U.S. NO. 4
UTILITY	NO. 5	UTILITY	CULL	UTILITY
CUTTER		CULL		
CANNER				



ANIMAL SCIENCE

Unit B: Livestock Evaluation

Topic 2: Performance and Production Testing

Note: All terms underlined are included in the "Glossary of Terms."

1. Production Testing

Production testing is an accurate method of determining the performance of livestock, while visual appearance is an inaccurate method of selecting animals. Valid production testing data is very useful in the identifying and selection of high-producing animals. Because more producers are recognizing the value of production tests, the number of animals being placed in testing programs is increasing. Tests are presently being conducted by breed associations, state universities, commercial firms, and individuals. The reputation of the firm conducting the test should be considered when reviewing test results.

Reasons for establishing testing programs are to increase production, efficiency, and improve quality. The two kinds of production tests are progeny and performance. Progeny tests are tests conducted on the offsprings of an animal. This is the best method for testing heritability traits. Progeny tests normally include the factors considered in a performance test plus many other factors. Performance tests are usually conducted on male animals and involve such traits as daily gains, feed conversion, growth rate, and grade. The test is based on a specific number of days.

2. Progeny Testing

The factors influencing progeny tests are discussed below:

Heritability of Traits--This factor affects improvement in livestock more than any other factor. The heritability of a trait also affects the rate of improvement for a particular trait. Because of its importance, it is essential that livestock producers be familiar with the heritability of the different traits of the livestock being produced.

An inherited trait which is affected only slightly by the environment is said to be highly heritable. The color of a black sheep is an example. Since environment has little effect on black color in sheep, it is 100 percent inherited. Most traits are not as highly heritable as the black color of sheep. In fact, a trait that is 50

percent or more heritable is rated as being highly heritable. Traits with a heritability of 30 to 49 percent have medium heritability, and those with less than 30 percent have low heritability.

Some traits, such as daily gains in cattle, are influenced by nutrition, parasites, and other factors. The percentage of the inheritance of these traits is estimated.

Transparency No. 1

Only a few traits are shown in the above transparency. Estimates of many more traits are available.

Environmental Influence--all animals possess certain traits that are influenced by the environment. Only animals raised, tested, or fitted under similar conditions should be considered when there is a possibility that the trait(s) will be influenced by the environment.

Cattle moved from a temperate to a tropical or subtropical area is an example of an environmental influence. These cattle tend to degenerate and become unproductive. They show signs of distress when the temperature reaches 85 degrees F.

Selection Differential--In any test group of animals, there will be some variation in performance. A few animals in the group will perform exceptionally well, while others will perform at an intermediate level. The performance of some animals will be at a lower level. Most of the animals in a group will have average production, or perform at an intermediate level. If the high performers are selected out of a group, the difference in their production and the average production of the group is the selection differential. The fewer the number of animals selected from a group, the greater the selection differential will be.

Transparency No. 2

Milk production is used in an example of selection differential. Other traits could be used.

A group of 16 cows are used in the example. In the group, one cow produced 9,000 lbs., two cows produced 10,000 lbs., three cows produced 11,000 lbs., etc. The average production for the group is 12,000 lbs. (total production divided by 16). A majority of the cows (10 head) are producing 12,000 lbs. or within 1,000 lbs. of the average production of the group. If the animals having average production are bred to a bull that transmits 12,000 lbs. of production, then the offsprings would be expected to produce at about the same level. There would be no genetic progress in this mating.

Using selection differential to make genetic progress, the better half of the dairy cows within the group would be selected and the other half disposed of. The average

milk production of the highest producing cows is 13,250 lbs. The difference between the original herd average and the selected herd average is 1250 lbs., the selection differential.

The average offspring from the cows in the selected group would be expected to produce more milk than the original herd average, but not 1250 lbs. more. Milk production in dairy cattle is 25 percent heritable; therefore, only about 25 percent of the 1250 lbs. would be transmitted to the offsprings. However, some of the offsprings would produce more.

The greater the difference (selection differential) between the selected animals and the original herd average, the greater the progress will be. Also, the more variance in the animals in a herd, the more likely the herd average can be increased.

Number of Traits as a Basis for Selection--Genetic improvement is much easier and faster when selection is based on a relatively small number of traits. There is a steady decline in progress as more traits are used as a basis for selection. Assuming one trait as 100 percent progress, the following rates of progress can be expected when selection is based on more than one trait: two traits, 70 percent; three traits, 58 percent; four traits, 50 percent; and five traits, 45 percent.

Animals possess both beneficially related (complimentary) and detrimentally (negative) related traits. The selection of animals based on one trait will often either improve or cause deterioration in another trait. Daily gain and backfat, related swine traits, are a good example. Swine having a high daily gain will produce more backfat than is desirable. Cattle breeders are fortunate in that cattle have more beneficially related traits than other species of livestock. Two beneficially related traits in cattle are rate and efficiency of gain. Every .25-pound increase in a steer's gaining ability improves feed efficiency 11 percent.

Generation Interval--The time normally required to replace the average animal in a herd is the generation interval. Generation interval and production lag, a term used by livestock market analysts, are closely related. Both are caused by biological factors (the time from breeding to birth and time required for maturity). Generation interval is the time required to make genetic change in a herd, while production lag is the time required to increase the number of animals and thus production.

Transparency No. 3

If only the best of each succeeding generation were kept in a breeding herd, the generation interval could be a shorter period; but it is not possible or practical to dispose of all other generations when a new generation becomes available. The approximate normal generation interval for the different species of livestock are beef cattle, 5 years; dairy cattle, 4 years; sheep, 4 years; and swine, 2 years.

Number of Offsprings--The more individuals there are to select from, the more progress that can be made.

After a review of the above information, it is evident that the speed in which genetic progress can be made through selection is influenced by the heritability of a trait, selection differential, the number of traits selected, and generation interval.

Transparency No. 4

Formulas that may be used to determine genetic progress are given in the above transparency. It is assumed in the examples that daily gain is 46 percent heritable, and a group of selected animals is gaining one-half pound per day more than the average animal in the herd. It is also assumed that equal emphasis is being placed on the selection of another trait. Progress is only 70 percent as great when selection is based on two traits.

3. Types of Selection

Three types of selection are used by livestock breeders in making genetic improvement to their herds. Each type is discussed.

One Trait or Tandem Selection--A breeder using this type concentrates on one trait until a certain level of performance is reached, then emphasis is placed on a second trait. Disadvantages of this type are animals with extremely poor traits will be selected for replacements; and when emphasis is placed on the second trait, the original trait regresses. The latter statement is particularly true if the traits are negatively correlated.

Independent Culling--This is a much better method than tandem selection because a standard for each trait is established. An animal not meeting the standard for a particular trait is culled regardless of the superiority of the other traits. Three considerations should be kept in mind when this method is used. They are: (1) traits should be of equal importance for best results; (2) improvement is in more than one trait simultaneously and is much faster; and (3) this method does not allow a slightly substandard performance in one trait to be offset by a performance greatly above the minimum established in another trait.

Net Merit Selection--Credit is given for a specific level of merit for each of the most important traits with this method. The animals in the group receiving the highest net score are selected. This method is the best and most effective for making overall herd improvement.

Procedures for using net merit selection are as follows:

1. Determine traits that will be basis for selection;
2. Establish value of each trait; and
3. Calculate the value of each trait passed to the offspring.

Since dairy cattle breeders often base selection on milk production and body type, these two traits are used as a basis for selection in the example in the following transparency.

Transparency No. 5

In step number 2, the value for each trait must be established. The value for milk production is easily determined, since milk is sold by the pound. The market price of milk can be the value for this trait. It is assumed that milk is selling for \$10.50 per hundred weight.

The value of type score is more difficult to determine, as type score may mean different things to different dairy cattle breeders. However, a cow with a higher type score may be more valuable because she is easier to milk, or more valuable if she is to be sold to another producer. The breeder will have to establish the value of type score. In the example, the type score is given a value of \$12.50 per unit.

When the two traits are totaled, cow No. 1 has a \$55 advantage in net merit. In the third step, the value of each trait passed on to the offspring is calculated. To do this, the heritability and selection differential must be determined. This is determined from herd averages. It is assumed that the herd production average is 11,500 lbs., and the average type score is 80. Cow No. 1 would be more valuable than cow No. 2 based on values established for the traits used in examples.

A summary of the principal factors on net merit selection is given below:

1. Overall improvement in the merit of animals is permitted, but there is less improvement in each trait when compared to the improvement when selection is based on one trait;
2. Heritability and economic values are of major importance in determining the traits to serve as a basis for selection;
3. The value of each trait depends on market demands and varies with the goals of the breeder;
4. Genetic relationships should be considered; and
5. Performance slightly below the established standard in one trait may be offset by outstanding performance in another trait.

4. Performance Tests

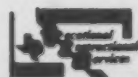
Performance tests are usually conducted on male animals because herd improvement is much faster when the better performing males are selected as herd sires, and the traits that serve as the basis for selection (weaning weight, growth rate, carcass grade, etc.) are highly heritable. Test results are fairly easily to evaluate; therefore, examples of completed tests are not shown.

Performance tests are a means of improving livestock; however, they are not a "cure-all" for the producer's problems. Other factors which should be considered are listed below:

1. The breeder must have clearly-defined, established goals;
2. Good production practices must be incorporated into any improvement program;
3. The producer's decisions will be influenced by the kind of animals being bred, purebred or grade;
4. Sex is always a factor in selection;
5. Present breeding in herd; and
6. Size of herd.

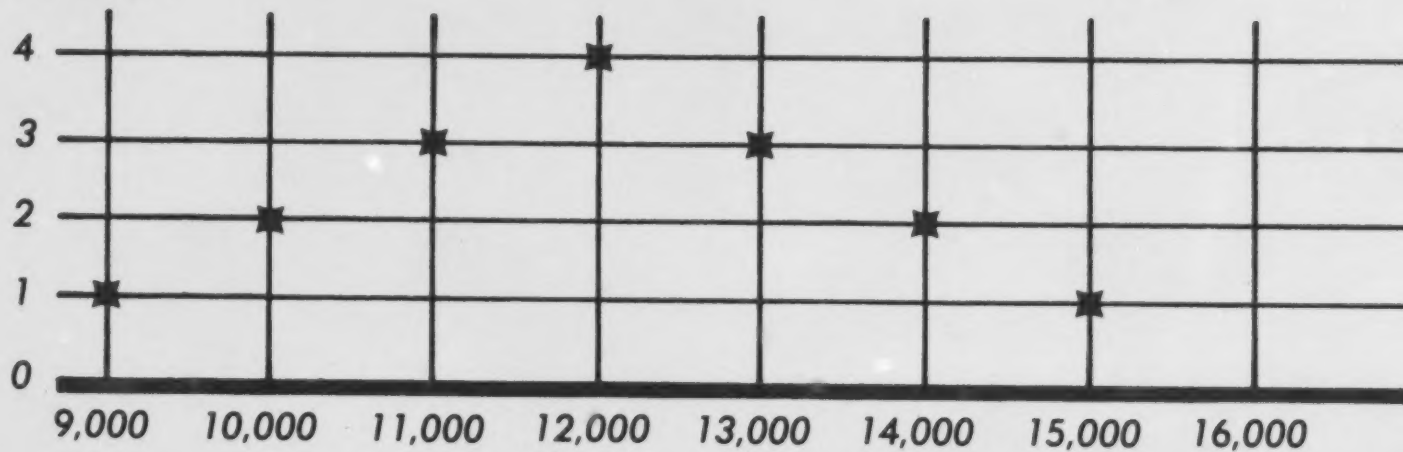
HERITABILITY ESTIMATES

TRAIT	BEEF CATTLE %	DAIRY CATTLE %	SWINE %	SHEEP %
BIRTH WEIGHT	45	45	5	30
WOOL FACE COVERING	—	—	—	50
DAILY GAIN	46	—	30	30
STAPLE LENGTH	—	—	—	45
FEED EFFICIENCY	39	50	30	—
MILK PRODUCTION	30	25		30
BACKFAT THICKNESS	—	—	50	—
WEANING WEIGHT	26	—	15	30
BODY CAPACITY	—	23	—	—
SLAUGHTER GRADE	38	—	—	—
PERCENT HAM	—	—	60	—



EXAMPLE OF SELECTION DIFFERENTIAL

NO. OF COWS

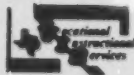


MILK PRODUCTION, LBS.

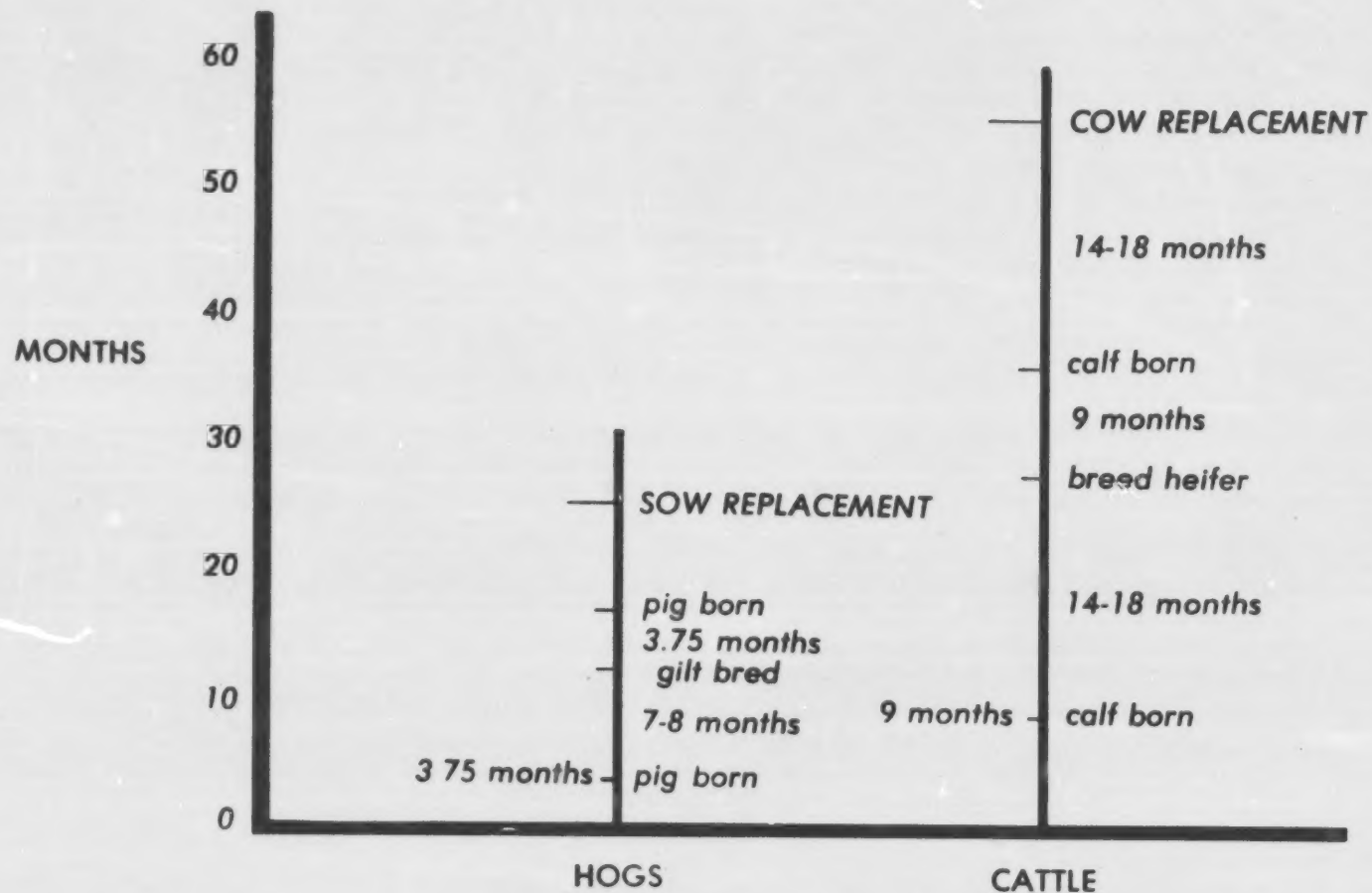
AVERAGE PRODUCTION OF 16 COWS IS 12,000 LBS.

AVERAGE PRODUCTION OF TOP 8 COWS IS 13,250 LBS.

SELECTION DIFFERENTIAL IS 1,250 LBS.



GENERATION INTERVAL



EXPECTED PROGRESS FOR EACH GENERATION

PROGRESS = %HERITABILITY X SELECTION DIFFERENTIAL X FACTOR FOR NUMBER OF TRAITS

EXAMPLE:

.46 - % heritability for rate of gain

.50 lb./day - increased gain of selected animals over herd average

- Progress is only 70% when selection is for two traits

$$.46 \times .50 \times .70 = .16 \text{ progress in daily gain in next generation}$$

With a generation interval of five years the estimated annual progress is:

$$\frac{.46 \times .50 \times .70}{5} = .032 \text{ progress in daily gains expected each year}$$

NET MERIT SELECTION

1. Basis for selection

(a) milk production

(b) body score

2. Value of each trait;

(a) value of milk is \$10.50/cwt.

(b) value of \$12.50/unit of body score

Cow No.	Production	Value of Trait	Body Score	Value of Trait
1	13,500 lbs	\$1,417.50	85	\$1,062.50
2	12,500 lbs.	\$1,312.50	89	\$1,112.50

Total Value of Traits 1 \$2,480.00

2 \$2,425.00

Cow 1 has \$55.00 advantage in net merit over cow 2 \$55.00

3. Calculated value of each trait passed to offspring;

Cow No. 1

Milk Production	Herd Ave.	Selection Differential	Heritability	Genetic Increase	Value Per Unit	Value Increase
13,500 lbs.	11,500 lbs.	2,000 lbs. x	.25 =	500 lbs. x	\$10.50 =	\$52.50
Type Score						
85	80	5 x	.30 =	1.5 x	\$12.50 =	\$18.75
						Net Merit \$71.25

Cow No. 2

Milk Production	Herd Ave.	Selection Differential	Heritability	Genetic Increase	Value Per Unit	Value Increase
12,500 lbs.	11,500 lbs.	1,000 lbs. x	.25 =	250 lbs. x	\$10.50 =	\$26.75
Type Score						
89	80	9 x	.30 =	2.7 x	\$12.50 =	\$33.75
						Net Merit \$59.90

ANIMAL SCIENCE

Unit C: Wildlife

Topic 1: Economic and Aesthetic Values of Wildlife

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedure and Activities: The local game warden should be asked to make a presentation before the class on the economic value of wildlife to the local economy.

1. The Importance of Wildlife to the Texas Economy

The term "wildlife" has different meanings to different people. Some think of birds as being wildlife, while others think of something different. In this topic the term is used to include those living things that live in the woods, prairies, and streams without being closely directed or controlled by man.

It is difficult to determine the specific dollar value of all wildlife to the economy, but the following information reveals that it is of great economic value. Recent figures released by the U.S. Fish and Wildlife Service show that almost 96 million Americans, about one-half of the population nine years of age and older participated in one or more forms of wildlife - related recreation during 1975. In a telephone survey of 106,000 households and the completion of an additional 20,000 individual questionnaires, it was estimated that there were 20.6 million hunters and 53.9 million anglers in 1975.

Other highlights of the survey were that Americans spent 478.6 million days and \$5 billion to hunt and 1.3 billion days and \$15.2 billion to fish. Included in these figures are \$4.6 billion spent in restaurants, markets, and other businesses for food; \$1.4 billion spent on motels and other lodging; \$4.3 billion spent on hunting and fishing equipment; and \$8.1 billion spent on transportation.

Data released by the Texas Parks and Wildlife Department show that the value of deer meat alone in Texas in 1975 amounted to \$12,055,050. There were 349,000 whitetail deer and 11,000 mule deer harvested.

The above data also stated that fishermen spent 17,780,000 days fishing in Texas saltwater bays and the Gulf of Mexico. The number of anglers is on the increase. In 1978 the Texas P & WD issued 978,290 licenses. This figure does not include anglers under 17 or over 65 years of age; those fishing in private waters; and fishing in county of residence with trotlines, throwlines, or lines having no reel or winding device attached. Although the following figures are believed by the Depart-

ment to be conservative, sales of bait, lures, and fuel alone accounted for \$56,010,000. Expenses for boats, motors, fishing tackle, and other equipment that anglers use on more than one trip are not included in the above figure.

Based on trapping surveys of some of the 12,000 licensed trappers in 1975 - 76, the Texas P & WD estimated the following number of pelts from fur-bearing animals were sold during the season: 430,510 raccoon, 198,115 opossum, 86,565 ringtails, 52,736 skunks, 48,484 coyotes, 45,481 nutria, 40,506 fox (red and gray), 15,898 bobcats, 13,157 muskrats, 4,063 mink, 3,236 civet, 2,798 beaver, 2,445 badger, 206 swift fox, and 63 otter. Records kept on a 22 county area in Central Texas indicate that during the 1976 - 77 season a total of 181,387 furs sold for more than \$2 million.

Presence of certain wildlife species has increased the demand for and value of land. In a study conducted in Brazos County, it was determined that a low deer density (one deer to 20-30 acres) increased the value of land \$50 per acre.

When the amounts spent for equipment, ammunition, hunting leases, fishing rights, transportation, lodging, bait boots, motors, and other items used in activities related to wildlife are considered, one can readily realize that wildlife has tremendous economic influence on the state and nation.

2. Aesthetic Value of Wildlife

The aesthetic value of wildlife is even more difficult to determine than the actual economic value. People do enjoy seeing the different forms of wildlife and appreciate its presence. Evidence of this fact is presented in the national survey which stated that 49 million people in the U.S. last year reported they spent time observing wildlife. People are probably more "wildlife conscious" today than at any other time in the history of our country. The possible reason for this is a large percentage of our population live in urban areas. They become tired of the concrete jungle and wish to get in the "open spaces" and close to nature, which includes wildlife and sports related to wildlife. After experiencing an enjoyable week-end hunting and fishing, the urbanite informs his neighbor of the good times. Many neighbors and friends are fishing and hunting together. This number is expected to increase.

A large number of people are of the opinion that wildlife has a great aesthetic value and believe hunting and fishing promote self-confidence, environmental awareness, and an opportunity for privacy and contemplation. The enjoyment from hearing a bird sing or a woodpecker dig his meal from the dead branch of a tree is important to them.

ANIMAL SCIENCE

Unit C: Wildlife

Topic 2: Environmental Factors Affecting Wildlife

Note: All terms underlined are included in the "Glossary of Terms."

1. Ecological and Environmental Relationships

Ecology, deriving from a Greek work meaning the "study of the home," is receiving extensive use by government leaders and others attempting to clean up our environment and to make this world a better place in which to live. Ecology and environment are very closely related factors that influence the lives of humans as well as wildlife. This relationship has been defined by ecologists as the interrelationship of living organisms and their environment.

When considering the ecological and environmental relationships, one may wish to take a look at the earth and determine which areas sustain life and make these relationships so very important. Living organisms are not found much higher than 10,000 feet, nor much deeper than a few feet in the earth's surface. If the above statement is true, the total thickness of that part of the earth which sustains life is only about three miles, a pretty thin slice. This area is called the biosphere, a place where life (bios) is found. To support life, the biosphere must have food. There are thousands upon thousands of different kinds of life which are affected directly or indirectly by the amount of food and kind of environment in the biosphere. All life in the biosphere follows a certain order.

To confine his thinking to an area with which he is familiar, the student of vocational agriculture might consider the environment and ecology of his own home farm or a relative's farm from the standpoint of how well it produces wildlife. Farms have a large number of living things which are supported by the soil. These living things convert nutrients, moisture, and sunshine into grass, flowers, and wildlife. Each form of life on the farm works for the benefit of all life on the farm. If there is a deficiency of nutrients in the soil, plants fail to grow, and wildlife does not have enough food to eat. Eventually, the wildlife dies. The factors that caused the unfavorable environment in the ecology are found on the farm.

One can see that the ecology and environment are closely related. The physiological processes of animals are closely related to the fluctuation of the environment. Growth, development, and even the sense organs of wildlife are directly correlated to their environment.

2. Wildlife Requirements

After reviewing the relationship between the environment, wildlife, and the home for wildlife, the wildlife conservationist should determine the requirements for propagating wildlife. This involves becoming familiar with the type of cover required for the particular species of wildlife one is attempting to propagate. Since this topic does not allow adequate space for a discussion of the habitat requirements for all species of wildlife, the discussion will cover the general requirements for wildlife.

If an area is to support a high wildlife population, there must be a plentiful supply of cover (protection, water, and food). The best way to provide cover is by planting and encouraging plants to grow next to natural cover.

Grass, weeds, stubble, shrubs, and trees are usually essential to provide cover and protection for wildlife. Most areas can be managed to provide adequate cover to support wildlife if certain management practices are followed on cropland and rangeland to encourage the growth of cover for wildlife.

Cropland--Grass and legume crops should be included in the cropping system. Other practices that may increase wildlife are strip crops, cover crops, the use of fertilizer, and leaving grain unharvested next to wildlife cover. If the conservationist is trying to increase the bird population on his wildlife management area, the mowing of roadsides and waterways in his fields should be delayed until after the nesting season.

Rangeland--Other practices which will help to increase wildlife are providing permanent water, controlling grazing to prevent overgrazing, planting of grasses and trees, fertilizing the pasture (This is not recommended for all areas of the state.), and providing areas for protection.

Most farms have some areas that are unproductive for the raising of livestock and crops, but these same areas can be made very productive for wildlife. They might include land that is too wet to plow or graze, land with excessive slope, fence rows, borders of fields, stream banks, and woodlands.

Nature usually produces more wildlife than an area can support, so the wildlife balances itself with its habitat. Excessive wildlife will usually die during the winter months when food becomes scarce. It is important that the farmer is able to recognize the proper stocking level of wildlife. By recognizing that his range will not support wildlife beyond a certain level, he can harvest the excessive game without damaging his wildlife population. The local wildlife conservation officer can assist the farmer in determining the proper wildlife population for his farm.

Weather and other conditions may reduce the wildlife population beyond the normal

level. If this happens and there is adequate cover and food, the wildlife population will eventually increase to its normal population. Wildlife management should be considered a part of the farm's total management program.

3. Wildlife Classification

All wildlife in Texas has been declared by state law to be the property of the people in the state. Texans are fortunate to have an abundance of many different kinds of wildlife.

According to game laws, wildlife is classified as game birds, unprotected birds, game animals, nongame animals, fur-bearing animals, and unprotected animals.

Fish are classified as game and nongame. Game fish are those that strike or bite at a hook baited with natural or artificial lures. These species should be encouraged to repropagate because of their value for sport and recreation. Nongame fish are those with no sporting value. These species are bony or rough-fleshed or may be one whose numbers should be controlled in order to protect and encourage game fish.

Transparency No. 1

The above transparency shows a list of the game birds in Texas. Some of these might be listed as unprotected birds in the state but are protected by federal laws.

Transparency No. 2

Not all counties in Texas classify the animals shown in the above transparency as game animals; however, they are classified as such in some counties. Unprotected are snakes, rabbits, armadillos, bats, rats, wolves, coyotes, prairie dogs, ground squirrels, Russian boars, and various wild cats.

Fur-bearing animals are the wild beaver, wild otter, wild mink, wild ring-tail cat, wild badger, wild polecat or skunk, wild raccoon, wild muskrat, wild opossum, wild fox and wild civet. It is unlawful for a person to have in his possession the pelts of these animals at any time other than the season which is provided. However, if a person does not take the pelt, he may hunt, take, or kill a fur-bearing animal at any time.

The student should check with the local conservation officer or request fishing and hunting guides from the Texas Parks and Wildlife Department, Austin, Texas, for local and state laws regarding hunting and fishing.

GAME BIRDS



PIGEONS



BRANT



GEESE



SNIFE



DUCKS



MOURNING DOVE



WHITE WINGED DOVE



SANDHILL CRANE



BOBWHITE
QUAIL



SCALED QUAIL



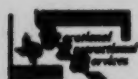
TURKEY



PHEASANTS



PRAIRIE CHICKEN
& GROUSE



GAME ANIMALS



BIG HORN SHEEP



DEER



ANTELOPE



ELK

GAME ANIMALS

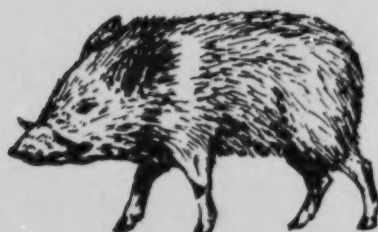


BLACK BEAR

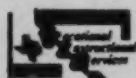


BISON (Buffalo)

JAVELINA



SQUIRREL



ANIMAL SCIENCE

Unit D: Livestock Facilities

Topic 1: Planning Livestock Facilities

Note: All terms underlined are included in the "Glossary of Terms."

1. Importance of Good Facility Planning in Livestock Operations

In order to effectively compete in the complex field of livestock production, the owner or manager of any livestock operation must make use of all available management tools. Since the livestock facility is one of the most important management tools, it should be carefully and thoroughly planned before it is constructed. A profitable operation is normally an efficient one, and it is almost impossible to have efficiency without prior planning. This includes consideration of long-range as well as immediate needs.

A good manager is constantly seeking ways to improve and increase the volume of business. In many instances this requires changes in the facility. These changes will be much easier to make when they have been anticipated and included in the original plan.

The livestock facility should permit the efficient production of livestock and animal products in a minimum length of time and with a minimum of labor. Facilities deficient in these areas will reduce profits and cause unnecessary labor.

2. Planning Land Requirements

Several factors should be considered in planning and determining the land required for the efficient production of a livestock enterprise. An explanation of several factors is given:

Transparency No. 1

Location—Selecting a suitable land area on which to locate a livestock enterprise is the basic requirement for beginning the new enterprise. The land area and its location will influence production and profits. Consideration should be given to the following factors in selecting a site:

1. Roads--The land area should be located adjacent to good roads. A successful enterprise will require the transporting of a large volume of supplies and commodities. If public roads are available, this will prevent the producer's having to build them.

2. **Available Supplies**--The livestock enterprise should be located in an area where feed and other supplies are available in large quantities.
3. **Vicinity**--The livestock operation should not be located in an area near a city or within an area that will come under the jurisdiction of city zoning or sanitation ordinances.
4. **Terrain**--The terrain is an important factor in selecting the location of some livestock enterprises, particularly those enterprises that require the close confinement of animals, such as a feedlot. Feedlots should be located on land that has a two to five percent slope. Mud creates a problem in areas with less than two percent slope. Earth moving equipment may be used in areas with too much slope. It is usually cheaper to create the desired slope rather than pave the feedlot. If possible, the feedlot site should be located at the top of a drainage area to prevent having to drain water from other areas through the feedlot drainage system. If it is not possible to locate the feedlot at the top of a drainage area, the drainage water from other areas should be diverted before draining onto the feedlot. Since south or southeast slopes provide natural protection from winter wind and are exposed to more direct sunlight, one should locate the feedlot on one of these slopes if possible.

Cost--The principal investment in most livestock enterprises is in land. If possible, the acquisition of land should be in an area where land and taxes are reasonable.

Size of Land Area--The land area must be large enough to support the present scope of the enterprise, plus enough for expected growth. If there is a possibility that the enterprise will require more space, land for the expansion should be bought with the initial purchase. If financing is not available for additional land at the time of the initial land purchase, the site should be selected in an area where land will be available for purchase or lease.

3. Planning Building Requirements for a Livestock Enterprise

The buildings required for a particular farm or ranch will vary according to the type of livestock operation involved, but certain general rules should be adhered to in all cases. Before constructing a farm building, the owner or manager should determine the purposes the building will serve. All livestock buildings should provide protective shelter, a controlled environment, and have a low labor requirement.

The shelter and environmental control requirements will be dependent upon the climatic conditions of the region where the enterprise is located. Research has shown that animals make more rapid gains on less feed under ideal temperature and humidity conditions. The investment in environmental control must be influenced by the expected return from livestock, keeping in mind that there is a point beyond

which returns on the investment will begin to decrease. Factors to consider in planning farm buildings are as follows:

Transparency No. 2

Labor saving devices should be incorporated into all farm buildings. High labor costs are a big problem for all livestock enterprises; and because of this factor, labor saving economies should be effected through proper building arrangement, proper size, and location of doors and passageways, elimination of interior columns and other structural obstacles, and the addition of proper utilities and mechanical equipment. Research has shown that labor requirements of some enterprises can be reduced as much as 80 percent with proper building arrangement and equipment.

Buildings for general farming and ranching operations should be designed with flexibility in mind. One-story buildings with a maximum of movable partitions have good flexibility, as do open sheds. They can be used to house livestock or to store feed and equipment.

Sanitation is another important aspect of farm buildings. They should be constructed so that they are easily cleaned, disinfected, and freed of rodents. Structures that afford entrance of direct sunlight provide for the elimination of excess moisture. Construction that permits operation of a mechanized manure loader will make cleaning easier and more economical.

Attractiveness is a factor sometimes overlooked in livestock buildings. It is not extremely important from the standpoint of building use and convenience, but it is important in areas such as pride of ownership and sale value of the property. In the case of purebred herds and flocks, attractive buildings have an enormous amount of advertising value.

The space requirements of livestock buildings will be dependent upon the class of livestock and the type of operation. In general, livestock buildings should be large enough to accommodate the existing herds and flocks, expected young stock, and any expected future expansion of the enterprise.

Proper lighting is another factor sometimes overlooked in livestock buildings. Light may be obtained through open doors and passageways, windows, artificial lights, or sheets of clear plastic roofing material. Most buildings are constructed using combinations of the previous four methods of lighting. No matter which of the methods is chosen, the building should be lighted adequately throughout.

All buildings housing any class of livestock should be properly ventilated. Animals in close confinement are extremely susceptible to disease, and proper ventilation is one good way to reduce or prevent disease problems. Moisture and foul odors should be removed with a minimum of temperature variation within the building and

without causing direct drafts. Proper ventilation may be secured by using open sheds, open doors and windows, building or stall partitions that are left slatted or open at the top, or a system of intake and outtake flues operated by gravity or forced air.

Livestock buildings should always be built with safety in mind - safety for both man and animals. Doors should be of sufficient width and height, and building floors should be of a material that prevents slippage. All sharp edges and pointed objects should be omitted, and structural safeguards against fire should be incorporated into construction.

4. Planning Fence and Pen Requirements for Livestock Enterprises

The kinds of fences and pens needed for a livestock operation will depend, as with other facilities, on the class of livestock and type of operation. The fences and pens that are necessary will probably represent a rather large investment, and mistakes will make them more expensive and less effective. Planners of livestock enterprises should select fencing or pen fabric and posts that will last about the same length of time.

Planning Efficient Fences--Although it is sometimes difficult to measure the financial return on fences, there are several distinct advantages to planning fences and building them properly.

Fences establish permanent boundary lines around property. Cross fences control the movement of livestock and in so doing keep animals separated. Good movement control over herds and flocks helps prevent the spread of disease and keeps quality livestock separated from scrub animals.

Boundary fences keep livestock off highway and roads and out of neighbors' fields and pastures. They also add to the attractiveness of livestock operations when kept in good condition.

Movable or temporary fences may be used in some types of livestock enterprises. They work well with pasture rotation systems and other operations where livestock are moved frequently or must be kept isolated for short periods of time.

The first step in planning is to sketch the layout of the enterprise. If the farmer is a cooperator of the local Soil and Water Conservation District, an aerial map of the farm will be available from them. If not, an aerial map of the area is probably available from the Agricultural Stabilization and Conservation Service.

Transparency No. 3

After an aerial map of the farm has been secured, proposed fences should be sketched on the map. Several factors should be considered when sketching the fences on the map.

Transparency No. 4

There are several different kinds of fences that a producer may build, some of which are woven wire, barbed wire, board, and electric. A combination of these may also be used, and in some areas of the United States rails, stones, and hedges have been used as fences.

The decision as to the kind of fence to build may be based on the following factors.

Transparency No. 5

5. Planning Water Facilities for a Livestock Enterprise

Water is needed by all classes of animals for the essential body processes (removal of waste, regulation of body temperature, and digestion and absorption of food nutrients). An animal can go a much longer period of time without food than it can without water. Since water is essential for animal growth and development and can usually be supplied at a fraction of the cost of other nutrients, an adequate supply should be made available to animals at all times.

The three factors having the greatest influence on the amount of water consumed by animals are weather conditions, amount of moisture in the feed the animal is eating, and whether or not the animal is lactating. As one is aware, animals consume more water in warm or hot weather. Also, lactating animals require more water. In addition to their body requirements for water, $3\frac{1}{2}$ to $5\frac{1}{2}$ pounds of water are required for each pound of milk produced.

The water requirements for different classes of animals are as follows:

<u>Animal</u>	<u>Daily</u> Water Requirements (gallons)
Dairy Cow, High Producing	up to 35
Dairy Cow, Dry	12
Dairy Animal, Growing	6-10
Beef Cow, Lactating	20-30
Beef Cow, Dry	8-12
Beef Animal, Growing	6-12

Sow and Litter	4-6
Boar, Mature	4-5
Pig, Growing	(1/2 to 1 1/2 for each 100# of body weight)
75 to 125#	1/2-2
125# to Market	1 1/2-3 1/2
Mare, Lactating	12-20
Horse, Mature	8-14
Ewe, Lactating	3-6
Ewe, Mature	2-3
Lamb	1/2-1
Chicks (100 head)	
1 to 4 Weeks	2
5 to 8 Weeks	5
9 to 12 Weeks	10
Laying Hens (100 Head)	5-10

Several factors must be considered in determining the water system to use. Some of these factors are climate, class of animal, production method, cost, availability of water, present watering system being used, sanitation, disease and insect control, and distance animals will have to travel to water. Regardless of the system selected, it should provide an adequate supply of readily available clean water if the producer expects maximum production.

6. Planning Feeding Facilities for a Livestock Enterprise

Feed is one of the largest single items of expense in any livestock operation. Proper facilities for storing and handling can greatly reduce waste and spoilage and, in turn, expense. Storage facilities should be large enough to handle feed amounts consistent with the size of operation.

Storage areas should be well constructed to prevent damage from the elements. Storage buildings and feeding facilities should be located and arranged so that the movement of feed from storehouse to the livestock will be as short a distance as possible. Care should also be taken to include as many labor saving devices as is economically feasible.

Feeding systems should be carefully planned to assure that all livestock have sufficient feeding space. The number of animals being fed, the type of ration being fed, availability of labor, and cost of equipment are all important items in the planning process. All feeding and storage facilities should be placed so that they may be easily reached by trucks and other farm equipment. Space for the maneuvering of trucks and equipment should also be provided.

References:

1. "Beef Cattle Feedlot Facilities," Texas Agricultural Extension Service, MP-680.
2. "Building and Equipment Plans," Texas Agricultural Extension Service, College Station, Texas.
3. "Modern Plans for Modern Farms," Portland Cement Association, Chicago, Illinois.
4. "Planning Farm Fences," AAVIM, Athens, Georgia.
5. "Planning the Machinery Storage and Shop Structures," AAVIM, Athens, Georgia.
6. "Pole Type Buildings," Texas Agricultural Extension Service, MP-638.
7. "Swine Housing and Equipment Handbook," Midwest Plan Service, Iowa State University, Ames, Iowa, 1968.

FACTORS TO CONSIDER IN PURCHASING LAND FOR A LIVESTOCK ENTERPRISE

LOCATION:

1. ROADS
2. AVAILABLE SUPPLIES
3. VICINITY
4. TERRAIN

COST:

SIZE OF LAND AREA:



FACTORS TO CONSIDER IN PLANNING BUILDINGS

LABOR SAVING DEVICES

Building arrangement
Size and location of doors and passageways
Elimination of interior columns and
structural obstructions
Mechanized equipment

FLEXIBILITY

Movable partitions
One story



SANITATION

Easily cleaned and disinfected
Rodent control
Entrance of sunlight

ATTRACTIVENESS

Pride of ownership
Favorable impression on prospective buyers

REQUIRED SPACE

LIGHTING AND VENTILATION

SAFETY

AERIAL MAP OF FARMSTEAD WITH PROPOSED FENCES

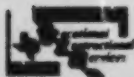


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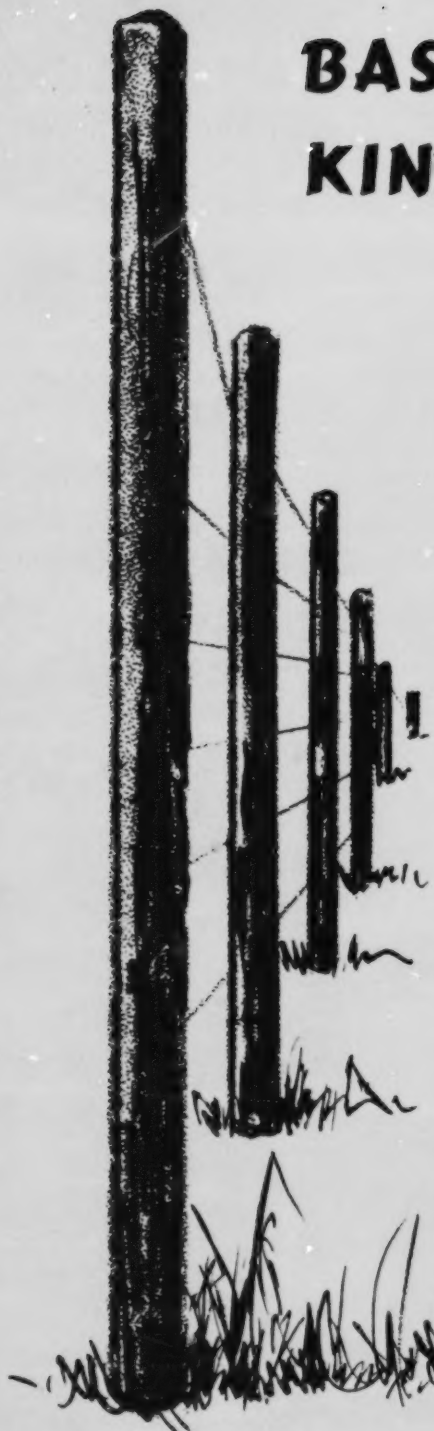
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No. 3

FACTORS TO CONSIDER WHEN SKETCHING IN THE FENCES

- Efficiency and a minimum of labor
- Convenience
- Fence should follow the crest or natural waterline division in a terraced area
- Contour fences should be used along terrace ridges
- Use straight fence as much as possible
- Fences should be laid out according to land capability classes
- Gates and other passageways should be included in the sketch
- Priority should be given to boundary fences
- Permanent pasture and crop land should be fenced after the boundary fences



BASIS FOR DETERMINING KIND OF FENCE TO BUILD



- Type of livestock
- Classes of livestock that will be run together
- Closeness of animal confinement
- Financing available
- Expected life of fence

ANIMAL SCIENCE
Glossary of Terms

1. Abortion - The presentation of a dead, undeveloped fetus.
2. Femoral Artery - A muscle in the thigh.
3. A. I. - Artificial insemination.
4. Grade animal - An animal with non-purebred ancestors.
5. Asexual - A method of reproduction performed by the division of a single cell.
6. Rotational Breeding - The using of one of three different breeds of cattle as a sire periodically. This maintains a high level of heterosis.
7. Egg Cell - A female germ cell.
8. Germ Cell - A cell from which new individuals are produced.
9. Sperm Cell - Male germ cell.
10. Centrosome - A minute protoplasmic body contained in the neck of sperm cells.
11. Lethal Characters - Genes that cause death in animals.
12. Chromosomes - Bodies found in the nucleus in pairs that contain genes which determine the hereditary characteristics of animals.
13. Conceive - A female animal that becomes pregnant.
14. Copulation - The physical union of the two sexes of the same species.
15. Criss Crossing - A method of breeding crossbred animals. Brahman bulls are usually bred to cows with British breeding and British bulls are usually bred to Brahman cows.
16. Estrus Cycle - The interval between heat periods.
17. Cytoplasm - The outside or covering over the nucleus.
18. Anatomic Defects - Defects in the anatomy of animals.
19. Incomplete Dominance - Neither character being dominant.
20. Egg - A reproductive cell.

21. Estrus - The period that an animal is in heat.
22. Fertility - Being fertile.
23. Fetus - Unborn animal.
24. Sigmoid Flexure - An "S" shape muscle that allows the penis to extend from the sheath.
25. Flushed - A term describing an animal that receives extra feed and care prior to breeding.
26. Follicle - A small cavity or depression and the area in which numerous eggs are produced in the female reproductive system.
27. Gametes - A reproductive cell before fertilization (male or female).
28. F1 Generation - The first generation out of a cross of two animals of different breeds.
29. Genitalia - The organs that make up the reproductive system.
30. Marking Harness - A harness strapped to a ram that marks a ewe's rump with crayon when she is bred by the ram.
31. Standing Heat - A female that freely accepts the stallion.
32. Scrotal Hernia - A hernia in the scrotum of an animal.
33. Heterosis - Hybrid vigor.
34. Heterozygous - An animal that carries genes for two different characters (impure).
35. Homozygous - An animal that carries genes for the same character (pure).
36. Incross - The progeny from the cross of individuals of inbred lines of the same breed.
37. Sexual Infantilism - The failure to develop sexually.
38. Artificial Insemination - The depositing of spermatozoa (sperm cells) into a female's genitalia by artificial means.
39. Lameness - A term describing an animal that is limping or cripple. It is usually caused by an injury.

40. Sex-linked - Characters developed from genes located on sex chromosomes. The character may be used to determine the sex of an animal. Barring of Barred Plymouth Rock chickens is an example.
41. Corpus Luteum - An endocrine body on the ovary and consisting of secretory cells which produce progesterone.
42. Maturation - The process of maturing.
43. Backcross Method of Mating - The breeding of F1 females to a bull of the same breed as the F1's parents.
44. Hand Mating - The turning of a cow with the bull.
45. Colostrum milk - Milk secreted by the female a few days after giving birth. It has a high protein and produces immunity to certain diseases.
46. Mitosis - The stages in cell division, or the division of cells.
47. Motility - The term used to express movement of sperms in the semen.
48. Mutation - A genetic change in animals that is hereditary.
49. Nucleus - The vital part of the cell which digests food, grows, and divides.
50. Ova - A female egg or gamete.
51. Ovum - Egg.
52. Crossing Over - The interchange of the entire segment of chromosomes.
53. Parturition - The giving birth to young.
54. Heat Period - The period in which an animal is in heat (estrus).
55. Placenta - The membrane which encompasses the fetus during pregnancy.
56. Potent - A male capable of producing pregnancy.
57. Presentation - An animal giving birth.
58. Protoplasm - The living materials within a cell.
59. Puberty - The age at which an animal reaches sexual maturity.
60. Conception Rate - The rate or percentage of animals becoming pregnant.
61. Rectum - Terminal part of the intestine from the sigmoid flexure to the anus.

62. Sexual - A method of reproduction which involves the union of sperm and an egg.
63. Spermatozoa - Male germ cell.
64. Sperms - Male germ cells.
65. Sterility - Not fertile. Animals that are incapable of reproducing are sterile.
66. Fertility Test - A test to determine if an animal is fertile.
67. Performance Test - A test to determine the performance of certain characteristics (usually growth factors) in animals.
68. Progeny Tests - A test to determine the heritability traits of the offsprings of an animal.
69. Testes - Male reproductive organs which produce sperm cells.
70. Testosterone - A male sex hormone produced by the testes.
71. Topcross - Breeding two different families of the same breed.
72. Topcrossbred - The progeny from the mating of inbred sires with noninbred dams of a different breed.
73. Topincross - The progeny from the mating of an inbred sire with a noninbred dam of the same breed.
74. Inherited Trait - A characteristic inherited by the offspring.
75. Twinning - Giving birth to twin lambs.
76. Identical Twins - Two animals of the same sex which developed from a single fertilized egg.
77. Uterus - Female reproductive organ connected to the oviducts. Fetal development occurs here.
78. Aesthetic Value - The value or pleasure that wildlife gives to individuals by its presence.
79. Vasectomized - Inducing permanent sterility through surgical procedures.
80. Embryonic Vesicle - An enlargement in one horn of the uterus.
81. Viable - A healthy, living cell or organism.
82. Cell Wall - The membrane around a cell.

SOIL SCIENCE

Unit A: Reading and Interpreting Soil Maps

Topic 1: Soil Mapping Units

Suggested Procedures and Activities: Copies of published soil surveys are ideal teaching aids to use for completing this soil science topic. Teachers in Texas can obtain soil surveys from their district or county soil conservationists or by requesting copies from the office of the State Conservationist, U.S.D.A. - Soil Conservation Service, P.O. Box 648, Temple, Texas 76501.

Note: All terms underlined are included in the "Glossary of Terms" at the end of this topic.

1. Soil Survey

A soil survey is an inventory of the physical land characteristics; it is the systematic examination, description, classification, and mapping of soils in an area.

Soil surveys are classified as exploratory, reconnaissance, or detailed soil surveys according to the kind and intensity of field examinations. Remote land areas usually have only an exploratory soil survey made for most of the land; reconnaissance soil surveys are available for intermediately intensive use areas; and detailed soil surveys are prepared for areas with greatly intensive or potentially intensive use. Most county soil surveys are of the latter type.

In performing a soil survey, soil scientists learn what soils are in the survey area, where they are, and how they can be used. They observe the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dig many holes to study soil profiles. They record the characteristics of the profiles and compare them with others in nearby counties or more distant places. Soil scientists classify and name the soils according to nationwide uniform procedures. They draw the boundaries of the soils on aerial photographs. This information is catalogued and discussed in published soil surveys prepared cooperatively by the State Agricultural Experiment Stations and the Soil Conservation Service.

Transparency No. 1

A published soil survey contains information that can be used in land-planning programs. It contains predictions of soil behavior for selected land uses. The

survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This information can be applied in managing farms and ranches; in selecting sites for roads, ponds, buildings, or other structures; and in appraising the value of tracts of land for agriculture, industry, or recreation.

Transparencies No. 2 and No. 3

The soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

2. Soil Classification System

Soils are classified into systems in the same manner as classification systems for plants, animals, and insects. The National Cooperative Soil Survey staff of the United States Department of Agriculture has developed a comprehensive system of soil classification. This "natural" or taxonomic system is based upon the relatively unchanging characteristics of the soil which are objectively measured and categorized.

Transparency No. 4

Beginning with the broadest, the categories in the general classification include: order, suborder, great group, subgroup, family, series, and soil phase. The two latter categories, series and soil phase, are used by soil conservation advisors and farmers.

ORDER

All soils are classified into ten orders. Differences among orders reflect the dominant soil - forming processes and the degree of soil formation.

Each order is identified by a word ending in "sol." An example is Entisol.

SUB-ORDER

Each order is divided into suborders primarily on the basis of properties influencing soil formation which are important to plant growth or properties that re-

flect the most important variables within the orders.

The last syllable in the name of a sub-order indicates the order. An example is Fluvent ("Fluv," meaning river, plus "ent," from Entisol).

GREAT GROUP

Each suborder is divided into great groups on the basis of (a) close similarities in kind, arrangement, and degree of development of the soil horizons; (b) soil moisture and temperature patterns; and (c) base status, that is, content of calcium, magnesium, sodium, potassium, gypsum, and other salts in the soil.

Each great group is identified by the name of a suborder and by a prefix indicating a property of the soil. An example is Udifluvents ("Ud," meaning humid, plus "fluvents," the suborder of the Entisols that are stratified and have irregular organic matter content).

SUBGROUP

Each great group has a typic (central) subgroup. Other subgroups are intergrades or extragrades. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties which are not representative of the great group but do not indicate transitions to any other known kind of soil.

Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective Typic identifies the subgroup that typifies the great group. An example is Typic Udifluvents.

FAMILY

Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. In most cases, the properties and characteristics are those of horizons below plow depth where much biological activity takes place. Among the properties and characteristics considered are particle-size class, mineral content, temperature pattern, root zone depth, consistence, moisture equivalent, slope, and permanent cracks.

A family name consists of the name of a subgroup preceded by terms indicating soil properties and characteristics. An example is sandy, mixed, thermic Typic Udifluvents.

SERIES

The series consists of soils having similar horizons in their profiles. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Published soil surveys identify soils by the series name. Characteristics of the soil and the material in which it forms are identified for each series. A pedon that is typical of the series in the published soil survey is described.

Series are given proper names from names of places near the first recorded occurrence of the soil. An example is Klamatia.

SOIL PHASE

Soils of one series can differ in texture of the surface layer or of the underlying material. They can also differ in slope, stoniness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into soil phases. Most of the areas shown on detailed soil maps in published soil surveys are phases of soil series. Prior to 1971, "soil type" was used to identify a subdivision of a soil series. Soil type is no longer used; it has been replaced by "soil phase" or "phase of series."

The name of a soil phase commonly indicates a feature that affects use or management. For example, Klamatia loamy fine sand, frequently flooded, is a phase in the Klamatia series.

3. Soil Mapping Units

Transparency No. 5

A soil association is a group of defined and named kinds of soils associated in a characteristic geographic pattern. All kinds of soil cannot be shown other than on detailed soil maps. Therefore, the areas of two or more kinds of soil geographically associated are grouped together. Sometimes this is called a "natural land type" or a "soil complex."

The Soil Association or General Soil Map of Brazos County in Texas indicates three general kinds of landscapes; flood plains, prairies, and post-oak savannahs. These broad landscapes are divided into soil associations which are shown on a map and indicated in the map legend. Series names are used to designate soil associations. The Soil Association Map of Brazos County shows seven soil series.

As discussed previously, all soils cannot be shown on a general soil map because of its small scale. Thus, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. However, the general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Transparency No. 6

Published soil surveys include detailed soil maps along with the general soil map

of the survey area. The map units on the detailed soil map represent the soils in the specific survey area. The map unit descriptions and the detailed soil map can be used to determine the suitability and potential of a soil for specific uses. They can also be used to plan the management needed for those uses.

Each map unit on a detailed soil map represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol (or a number) identifying the soil precedes the map unit name in the soil descriptions. Soil phases are used for map unit descriptions. More detailed information on each map unit, or soil, is given in a separate section of the published soil survey.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ greatly from those of the major soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. For example, Roebuck soil is shown on the detailed soil map but is not included on the general soil map of Brazos County, Texas.

Some small areas of strongly contrasting soils are identified by a special symbol on the soil map. For example, Gd on the detailed soil map represents gullied land.

Transparencies No. 7a and No. 7b

On detailed soil maps, symbols are used to designate pertinent information and strategic points such as works and structures, boundaries, water features, and special soil survey features.

4. How to Use a Published Soil Survey

Transparencies No. 8a and No. 8b

Soil surveys are beneficial only if they are effectively used. The soil survey will provide useful information to the user if the steps in using it are carefully followed.

References:

1. "A Proposal for Accelerating the Soil Survey of Texas," U.S.D.A., S.C.S., Texas Agricultural Extension Service, College Station, Texas, 1980.
2. Bartelli, L.J. and others, Soil Surveys and Land Use Planning, Soil Science Society of America and American Society of Agronomy, Madison, Wisconsin, 1976.
3. Donahue, Roy L., Raymond Miller, and John Shickluna, Soils - An Introduction to Soils and Plant Growth, 4th ed., Prentice - Hall Inc., Englewood Cliffs, N.J.,

1977, Chapters 20 and 21, pp. 408-450.

4. "Know Your Soil," Agricultural Information Bulletin No. 267, U.S.D.A., S.C.S., Washington, D.C., February, 1963.
5. Knuti, Leo L., Milton Korpi, and J.C. Hide, Profitable Soil Management, 2nd. ed., Prentice - Hall, Inc., Englewood Cliffs, N.J., 1970, Chapter 2, pp. 24-32.
6. Soil Survey - Brazos County, Texas, Series 1951, No. 1, U.S.D.A., S.C.S., Texas Agricultural Experiment Station, June, 1958.
7. Soil Survey of Bowie County, Texas, U.S.D.A., S.C.S., Texas Agricultural Experiment Station, October, 1980.
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9. Stallings, J.H., Soil Conservation, 1st. ed., Prentice - Hall, Inc., Englewood Cliffs, N.J., 1957, Chapter 7, pp. 117-139.

GLOSSARY OF TERMS

Aerial photograph - a picture of a soil survey area taken from an airplane at about 12,500 feet (3,810 meters) above the surface of the earth. Photographs are taken of the same landscape from different angles. Soil scientists study the photographs (field sheets) and use them to map soils. Detailed soil maps with a scale of 1:20000 are developed from aerial photographs.

Consistence - the combination of properties of soil material that determines its resistance to crushing and its ability to be molded or changed in shape. Terms commonly used to describe consistence are loose, friable, firm, soft, plastic, sticky, hard, and cemented.

Detailed soil map - a soil map on which the boundaries between different soil phases are shown. The map is designed to show the distribution of soil phases or other soil mapping units in relation to the prominent physical and cultural features of the earth's surface.

Detailed soil survey - a soil survey in which the location of each boundary plotted on the soil map is observed throughout its course.

Exploratory soil survey - a soil survey in which the boundaries are plotted on the soil map only after thorough exploration of the remote land areas involved.

General soil map - a soil map on which the boundaries between different soil series are shown. Soils between boundaries have similar properties but are not as specifically described as soils on a detailed soil map.

Pedon - the smallest volume that can be called "a soil." A pedon is three-dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil horizons.

Physical land characteristics - those characteristics, processes, or reactions of soils caused by physical forces expressed in physical terms and used to determine the various land classes. Soil texture, permeability, depth, slope, moisture storage capacity, and surface drainage are used to describe physical land characteristics.

Published soil survey - soil survey information published for use in land-planning programs. It contains predictions of soil behavior for selected land uses. Broad areas of soil are shown on a general soil map. The location of each soil is shown on detailed soil maps. Each soil in the survey area is described, and information on specific uses is given.

Reconnaissance soil survey - a soil survey in which the boundaries between mapping units are plotted on the soil map from observations made at intervals. Boundaries

are not plotted throughout their whole course.

Soil classification - the study of soils, their interrelationships, and their properties. It is the naming and systematic grouping of soils. The taxonomic units are frequently regrouped for various purposes, such as drainage requirements, crop adaptations, highway construction, and forestry purposes.

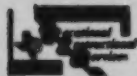
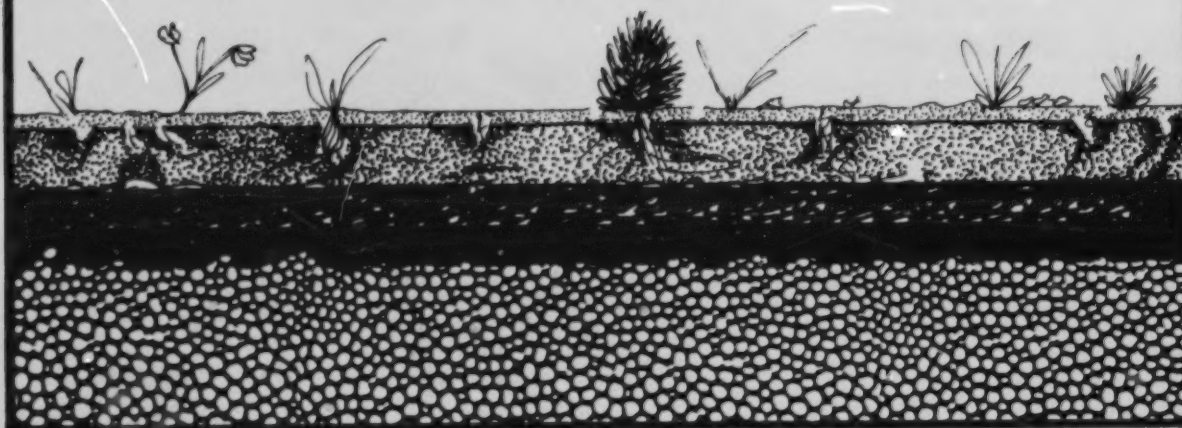
Soil profile - a vertical section of the soil extending through all its horizons and into the parent material.

Stratified - refers to geologic material arranged in strata, or layers. Layers in soils resulting from soil formation processes are called horizons; those inherited from the parent material are called strata.

Substratum - the C horizon or part of the soil below the solum. The solum in soil consists of the A and B horizons.

A SOIL SURVEY SHOWS

1. SUITABILITY OF LAND FOR MANY USES, AS WELL AS ITS LIMITATIONS
2. SLOPE OF LAND—WHETHER LEVEL, ROLLING, OR STEEP
3. KINDS OF SOIL—HOW MUCH CLAY, SAND, AND SILT
4. DEGREE OF SOIL EROSION—SLIGHT TO SEVERELY GULLIED
5. DEPTH OF SOIL LAYERS AND COMPOSITION OF EACH
6. DEGREE OF SOIL WETNESS—WHETHER IT NEEDS DRAINAGE OR IS SUBJECT TO FLOODING
7. SOIL SALINITY PROBLEMS
8. SOILS CLASSIFIED INTO DEFINED AND DESCRIBED UNITS
9. SOIL UNITS LOCATED AND PLOTTED ON MAPS
10. MAPS WITH DISTRIBUTION OF SOILS AND SUGGESTIONS AS TO THEIR USE AND MANAGEMENT



FARM AND RANCH USES OF SURVEYS

I. PROVIDES MORE EXACT KNOWLEDGE OF SOILS FOR LAND CAPABILITY CLASSIFICATION

- A. SOIL DEPTH
- B. TEXTURE OF SURFACE SOIL
- C. PERMEABILITY OF SUBSOIL
- D. MOISTURE STORAGE CAPACITY
- E. INTERNAL DRAINAGE
- F. DEGREE OF ACIDITY OR ALKALINITY
- G. AMOUNT OF ORGANIC MATTER
- H. AMOUNT OF PLANT NUTRIENTS



II. AIDS IN DEVELOPING SOUND MANAGEMENT PLANS FOR CARE AND TREATMENT OF LAND FOR:

- A. FISH, WILDLIFE, RECREATION, GRASSLAND, AND RELATED USES OF THE LAND
- B. LOCATING PONDS TO PROVIDE WATER FOR FARM USE AND RECREATION
- C. CROPLAND AND WOODLANDS AND PROTECTION OF WATER SHEDS
- D. CONSERVATION-TREATED FIELDS AND WELL-MANAGED WOODLOTS AND GRASSLANDS

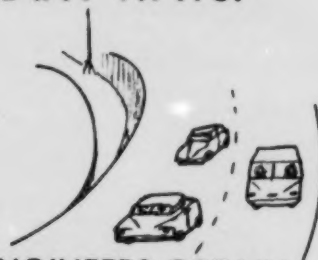


NON-FARM USES OF SOIL SURVEYS

SURVEYS ARE WORKING TOOLS FOR PROFESSIONALS WHO DEAL WITH THE SOIL IN MANY WAYS.

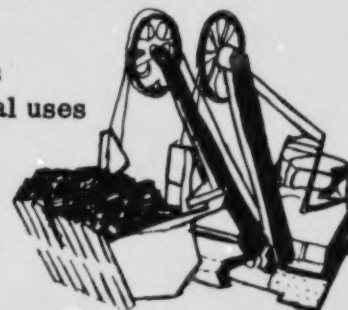
I. HIGHWAY ENGINEERS USE THEM TO:

- A. Locate best routes for roads
- B. Find road building materials
- C. Plan ways to protect road shoulders and fills



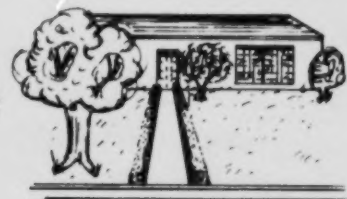
II. PLANNERS, DEVELOPERS, BUILDERS, AND ENGINEERS OBTAIN INFORMATION CONCERNING:

- A. Soils best suited for homes and other structures
- B. Soils best suited for parks, roads, and industrial uses
- C. Areas subject to flooding
- D. Wet soils that can be drained
- E. Soils that corrode water and gas pipes
- F. Sand, clay, gravel, and topsoil excavation sites
- G. Mechanical analysis of soils



III. HOMEOWNERS OR BUYERS SHOULD KNOW:

- A. Flood hazards of the land area
- B. Limitations for septic tank absorption fields
- C. Soils that will grow trees, flowers, lawn grasses, and other plants
- D. Soils that require special care with foundations, basements, or underground installations



IV. OTHER USERS WHO FIND SOIL SURVEYS HELPFUL INCLUDE:

Nursery and Landscape Operations, Insurance Companies, Teachers, Students, Homeowners, Foresters, Conservationists, and Specialists in Recreation, Wildlife, Waste Disposal, and Pollution Control.

SOIL CLASSIFICATION SYSTEM OF THE NATIONAL COOPERATIVE SOIL SURVEY

I. ORDER

A. SUBORDER

1. GREAT GROUP

a. SUBGROUP

(1) FAMILY

CATEGORIES USED BY SOIL
CONSERVATION ADVISORS
AND FARMERS

{ (a) SERIES

① SOIL PHASE

EXAMPLE:

I. ENTISOL

A. FLUVENT

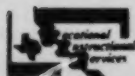
1. UDIFLUVENTS

a. TYPIC UDIFLUVENTS

(1) SANDY, MIXED, THERMIC TYPIC
UDIFLUVENTS

(a) KIOMATIA

① KIOMATIA LOAMY FINE
SAND, FREQUENTLY FLOODED



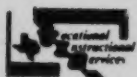
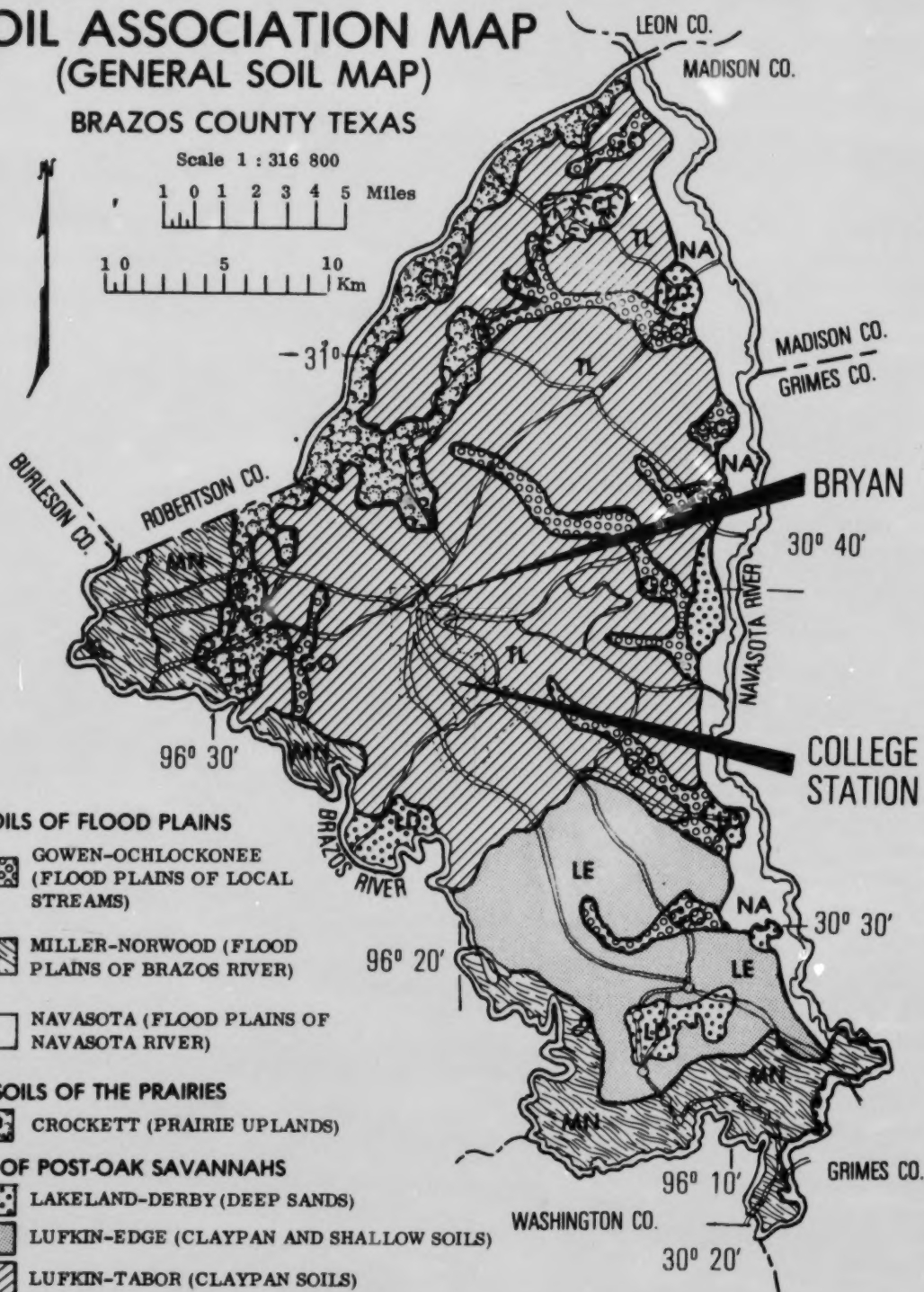
SOIL ASSOCIATION MAP (GENERAL SOIL MAP)

BRAZOS COUNTY TEXAS

Scale 1 : 316 800

1 0 1 2 3 4 5 Miles

1 0 5 10 Km



V. A. III

III-A-1
No. 5

DETAILED SOIL MAP

MAP SHEET NO.22
BRAZOS COUNTY, TEXAS

Scale: 1 : 20 000

0 2000 Feet
0 500 Meters

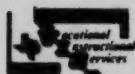


SOIL LEGEND

SYMBOL

NAME

Gd	Gullied Land
Mb	Miller Clay, 0-1 percent slopes
Md	Miller Silt Loam, 0-1 percent slopes
Nb	Norwood Silt Loam, 0-1 percent slopes
Nc	Norwood Silt Loam, 3-8 percent slopes
Nd	Norwood Silty Clay Loam, 0-1 percent slopes
Ra	Roebuck Clay, 0-1 percent slopes



V. A. III

III-A-1
No. 6

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

WORKS AND STRUCTURES

Roads

Good motor	
Poor motor	
Trail	
Marker, U.S.	

Railroads

Single track	
Multiple track	
Abandoned	

Bridges and crossings

Road	
Trail, foot	
Railroad	
Ferry	
Ford	
Grade	
R.R. over	
R.R. under	
Tunnel	

Buildings

School	
Church	
Station	

Mine and Quarry

Shaft	
Dump	
Prospect	
Pits, gravel or other	

Power line

Pipeline

Cemetery

Dam

Levee

Tank

Oil well

Windmill

Canal lock (point upstream)

Cotton Gin

BOUNDARIES

National or state

County

Township, civil

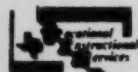
U.S.

Section

City (corporate)

Reservation

Land grant



CONVENTIONAL AND SPECIAL SYMBOLS LEGEND (con't.)

WATER FEATURES

DRAINAGE

Perennial, double line	
Perennial, single line	
Intermittent	
Drainage end	
Canals or ditches	
Double-line (label)	
Drainage and/or irrigation	

LAKES, PONDS AND RESERVOIRS

Perennial	
Intermittent	

MISCELLANEOUS WATER FEATURES

Marsh or swamp	
Spring	
Well, artesian	
Well, irrigation	
Wet spot	

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS ~~CnB~~ ~~Wc2~~

ESCARPMENTS

Bedrock (points down slope) ...	
Other than bedrock (points down slope)	

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown)

MISCELLANEOUS

Blowout

Clay spot

Gravelly spot

Gumbo, slick or scabby
spot (sodic)

Dumps and other similar
non soil areas

Prominent hill or peak

Rock outcrop (includes
sandstone and shale)

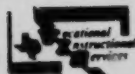
Saline spot

Sandy spot

Severely eroded spot

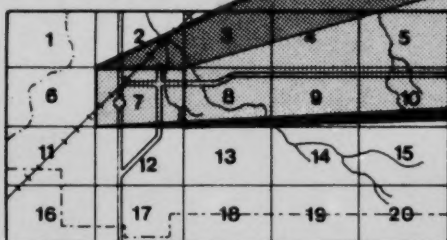
Slide or slip (tips point upslope) ...

Stony spot, very stony spot



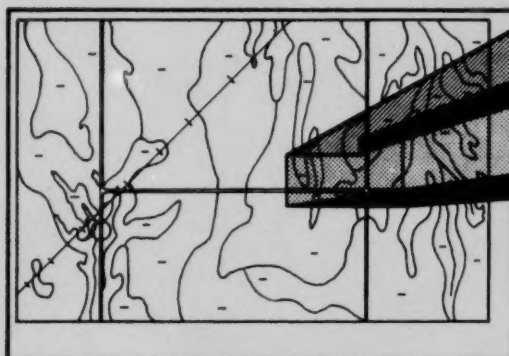
HOW TO USE A PUBLISHED SOIL SURVEY

1. Locate your area of interest on the "Index to Map Sheets" (the last page of the soil survey publication).



2. Note the number of the map sheet and turn to that sheet.

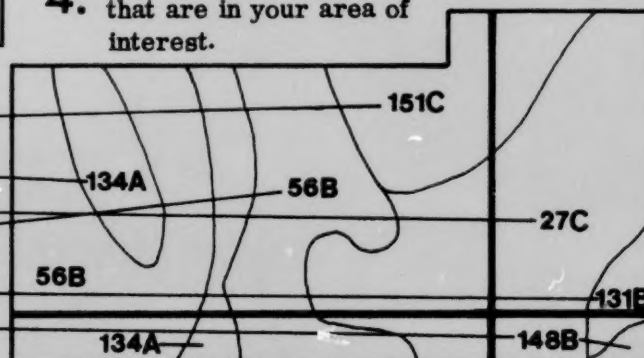
3. Locate your area of interest on the map sheet.



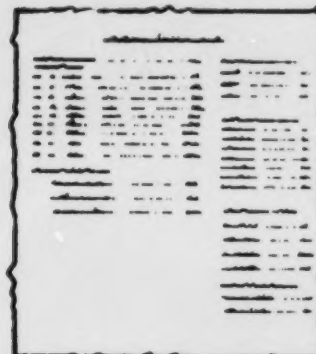
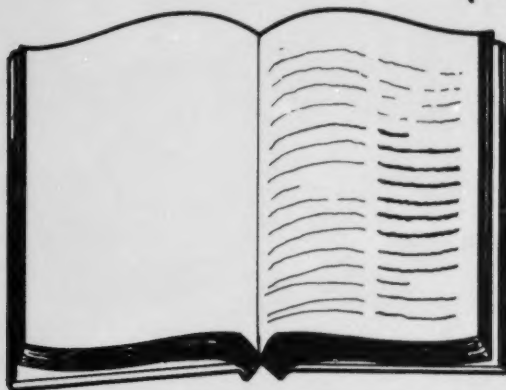
4. List the map unit symbols that are in your area of interest.

SYMBOLS

151C
134A
27C
56B
131B
148B



HOW TO USE A PUBLISHED SOIL SURVEY (con't.)



5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.

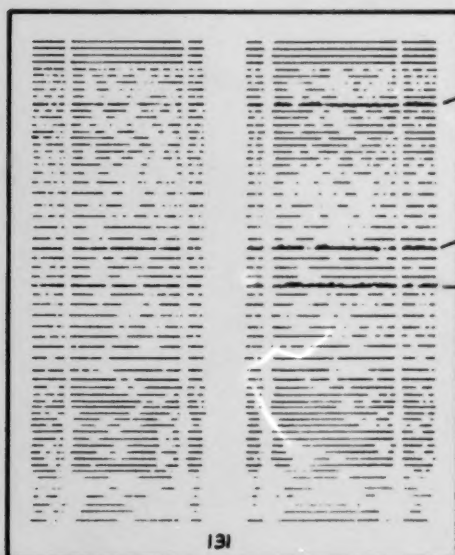


TABLE 1

Soil Map Unit	Page	Soil Map Unit	Page	Soil Map Unit	Page	Soil Map Unit	Page

TABLE 12

Soil Map Unit	Page	Soil Map Unit	Page	Soil Map Unit	Page	Soil Map Unit	Page

TABLE 18

Soil Map Unit	Page	Soil Map Unit	Page	Soil Map Unit	Page	Soil Map Unit	Page

6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.

7. Consult "Contents" for parts of the publication that will meet your specific needs.

SOIL SCIENCE

Unit A: Reading and Interpreting Soil Maps

Topic 2: Capability Maps and Numbering Systems

Suggested Procedures and Activities: Copies of a land capability map and land use map for a local farm or ranch are ideal teaching aids to use in completing this soil science topic. These maps can be obtained directly from the farmer/rancher or borrowed from the district or local soil conservationist.

Note: All terms underlined are included in the "Glossary of Terms" at the end of this topic.

1. Introduction

Do contractors construct houses without a building plan (blueprint)? Can farmers and ranchers utilize their land effectively without conservation plans? The answer to both of these questions should be a definite "no!"

In addition, plans should be effectively used to be of any value. An inaccurate reading of a blueprint by the contractor may make the house structurally unsound; a wrong interpretation of a proposed land use map by the farmer or rancher may destroy the productivity of the soil.

To effectively use a conservation plan, farmers and ranchers should be knowledgeable in the use of soil maps and the land capability classification system. Why? The reason is simple. Conservation plans are actually detailed soil maps and land capability maps combined, interpreted, and transformed into a proposed land use map.

Transparency No. 1

The soil map shows the kinds of soils, steepness of slope, and the amount of erosion that has taken place. The soil map is located in the published soil survey.

2. Land Capability Classification

Transparency No. 2

The local soil conservationist will assist the farmer, rancher, or other land owner in preparing a land capability map. Soil map information is used to place the soils into capability groups.

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils. Furthermore, the grouping does not take into consideration possible but unlikely major reclamation projects, nor does it apply to crops that require special management.

The land capability map is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, forest trees, or engineering purposes. The proposed land use map will serve those purposes.

In the capability system, the kinds of soils are grouped at three levels: capability class, subclass, and unit. These are discussed in the following paragraphs.

CAPABILITY CLASS

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and landforms have limitations that nearly prevent their use for commercial plants.

Land capability maps are usually color coded for ease in differentiating capability classes.

CAPABILITY SUBCLASS

Capability subclasses are soil groups within one class; they are designated by adding a small letter, e, w, s, or c, to the class numeral, for example, IIe. The letter e indicates the main limitation is risk of erosion unless close-growing plant cover is maintained; w indicates water in or on the soil interferes with plant growth or cultivation (in some soils, wetness can be partly corrected by artificial drainage); s indicates the soil is limited mainly because it is shallow, droughty, or stony; and c, used in only some parts of the United States, indicates the chief limitation is climate - too cold or too dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by w, s, or c because the soils in class V are subject to little or no erosion, though they have other limitations restricting their use to pasture, range, woodland, wildlife habitat, or recreation.

CAPABILITY UNIT

Capability units are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils.

Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIIe4 or IIw2. Thus, in one symbol, the roman numeral designates the capability class or degree of limitation; the small letter indicates the subclass or kind of limitation; and the Arabic numeral specifically identifies the capability unit within each subclass.

Although land capability maps are not located in published soil surveys, the capability units are described in the soil surveys with suggestions for use and management of the capability units.

Transparency No. 3

A soil and land capability map is simply prepared by combining the soil phases on the soils map with the capability units on the land capability map.

A map legend for each soil grouping is included with the soil and land capability map.

This type of map is also an example how symbols can be effectively used and make it possible to place much information on a small space of the map by use of a code.

When the land owner and the soil conservationist start planning for the most intensive use of the farm, they need a soil and land capability map to prepare a conservation plan map or proposed land use map.

Transparency No. 4

The soil conservationist and the land owner, through the use of the soil and land capability map, discuss the kinds of soil on the farm. The present or original land uses are discussed and noted on the map.

Transparency No. 5

In developing a proposed land use map, the soil conservationist will need to know what the personal goals or objectives of the landowner are for developing the land.

Many things may be involved in reaching land use decisions field by field. Boundaries may need to be changed so all the soil in each field is suited for the same purpose. The desired balance between cropland, pasture, woodland, and other land uses will need to be considered. If there is a good potential for income-producing recreation enterprises in the community, an area may be used for hunting areas, campsites, or fishing.

In addition to the use of each field, the landowner will need to consider how to treat each field to get the desired results. This usually involves more than one conservation practice on each field. The SCS conservationist can give many good suggestions, but the landowner must decide what to do and when and how to do it. As planning decisions are made, the conservationist will record them on a conservation plan map in an understandable narrative form. This is the farm conservation plan. It is the guide for the farming operation for several years.

Workers from the Soil Conservation Service are also available to give on-site technical assistance to the landowner in applying and maintaining the farm conservation plan.

References:

1. Donahue, Roy L., Raymond Miller, and John Shickluna, Soils - An Introduction to Soils and Plant Growth, 4th ed., Prentice - Hall, Inc., Englewood Cliffs, N.J., 1977, Chapters 20 and 21, pp. 451-459.
2. "Know Your Soil," Agricultural Information Bulletin No. 267, U.S.D.A., S.C.S., Washington, D.C., February, 1963.
3. "Program and Plan," Brazos-Robertson Soil Conservation District, No. 431, Bryan, Texas, 1964.
4. Soil Survey - Bexar County, Texas, Series 1962, No. 12, U.S.D.A., S.C.S., Texas Agricultural Experiment Station, June, 1966.

5. Soil Survey - Brazos County, Texas, Series 1951, No. 1, U.S.D. A., S.C.S., Texas Agricultural Experiment Station, June, 1958.
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7. Soil Survey of Harris County, Texas, U.S.D. A., S.C.S., Texas Agricultural Experiment Station, Harris County Flood Control District, August, 1976.
8. Soil - The Yearbook of Agriculture - 1957, U.S.D. A., Washington, D.C., pp. 400-411.
9. Stallings, J.H., Soil Conservation, 1st ed., Prentice - Hall, Inc., Englewood Cliffs, N.J., 1957, Chapter 7, pp. 424-448.
10. "What Is A Farm Conservation Plan?", United States Department of Agriculture, Soil Conservation Service, PA-629.

GLOSSARY OF TERMS

Land capability classification - a grouping of kinds of soil into special units, sub-classes, and classes according to their capability for intensive use and the treatments required for sustained use.

Land capability map - a soil map on which the boundaries between all land capability classes are shown.

Landforming - the movement of soil by mechanical means which results in a general change of the physical features of the land area.

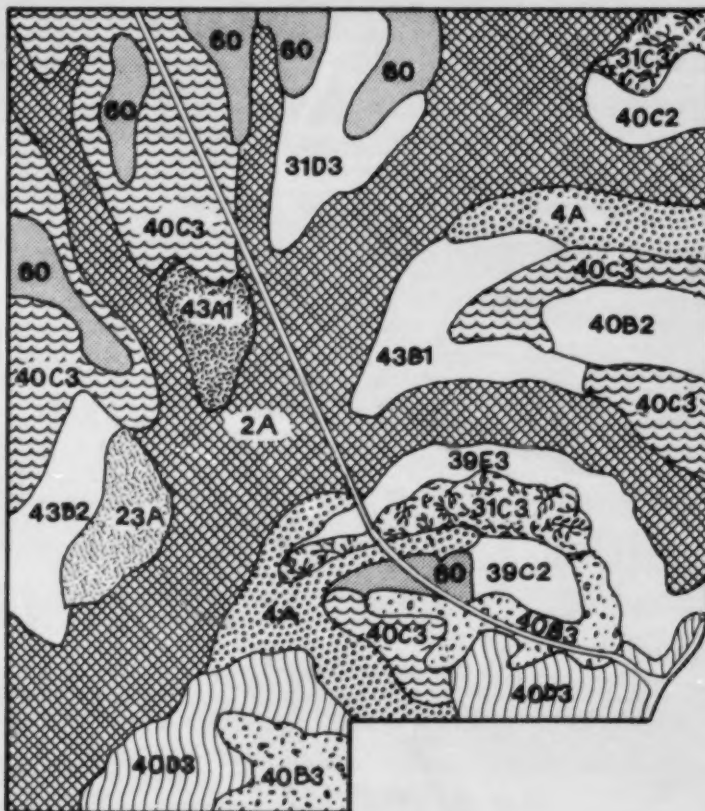
Land use map - a soil map on which the boundaries between all original or planned uses of the land are shown.

Productivity - the present capability of a kind of soil for producing a specified plant or sequence of plants under a defined set of management practices.

Reclamation project - a project to restore a land area to productive use. Reclamation projects will usually necessitate a change in the land capability classification of the affected land area.

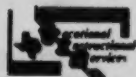
Soil map - a map designed to show the distribution of soil phases or other soil mapping units in relation to a prominent physical and cultural feature of the earth's surface.

SOIL MAP

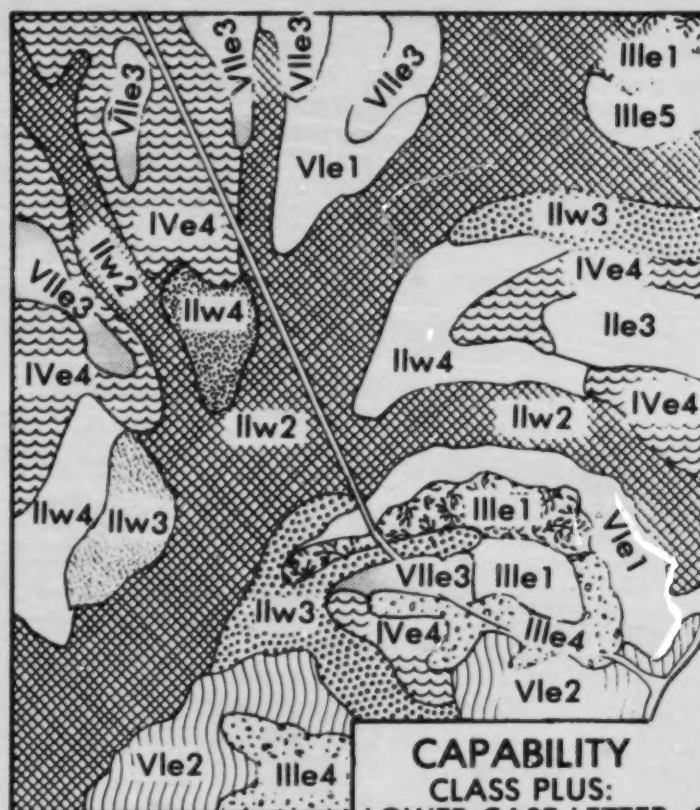


LEGEND

Soil - silt loam -	Slope	Erosion
2- COLLINS	A- 0-2%	1- LITTLE OR NONE
4- FALAYA	B- 2-5%	2- MODERATE
23- HENRY	C- 5-8%	3- SEVERE
31- LORING	D- 8-12%	
39- MEMPHIS AND NATCHEZ	E- 12-17%	
40- GRENADA		
43- CALLOWAY		
60- GULLIED LAND		



LAND CAPABILITY MAP

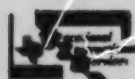


CAPABILITY CLASS		
NUMERAL		COLOR CODE
I	—	Light green
II	—	Yellow
III	—	Red
IV	—	Blue
V	—	Dark green
VI	—	Orange
VII	—	Brown
VIII	—	Purple

CAPABILITY SUBCLASS
CLASS PLUS:
LOWER CASE LETTER SOIL LIMITATION

e Erosion
w Excess water
s Shallow, droughty,
or stony soil
c Climate too cold
or too dry

CAPABILITY UNIT
CLASS AND SUBCLASS PLUS:
Arabic Numbers (1, 2, 3, etc.)
*Soils with same capability unit are
enough alike to be suited to the
same crops and similar
management*



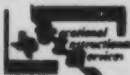
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Example No. 1 llw4 - 43A1, 43B1, & 43B2.

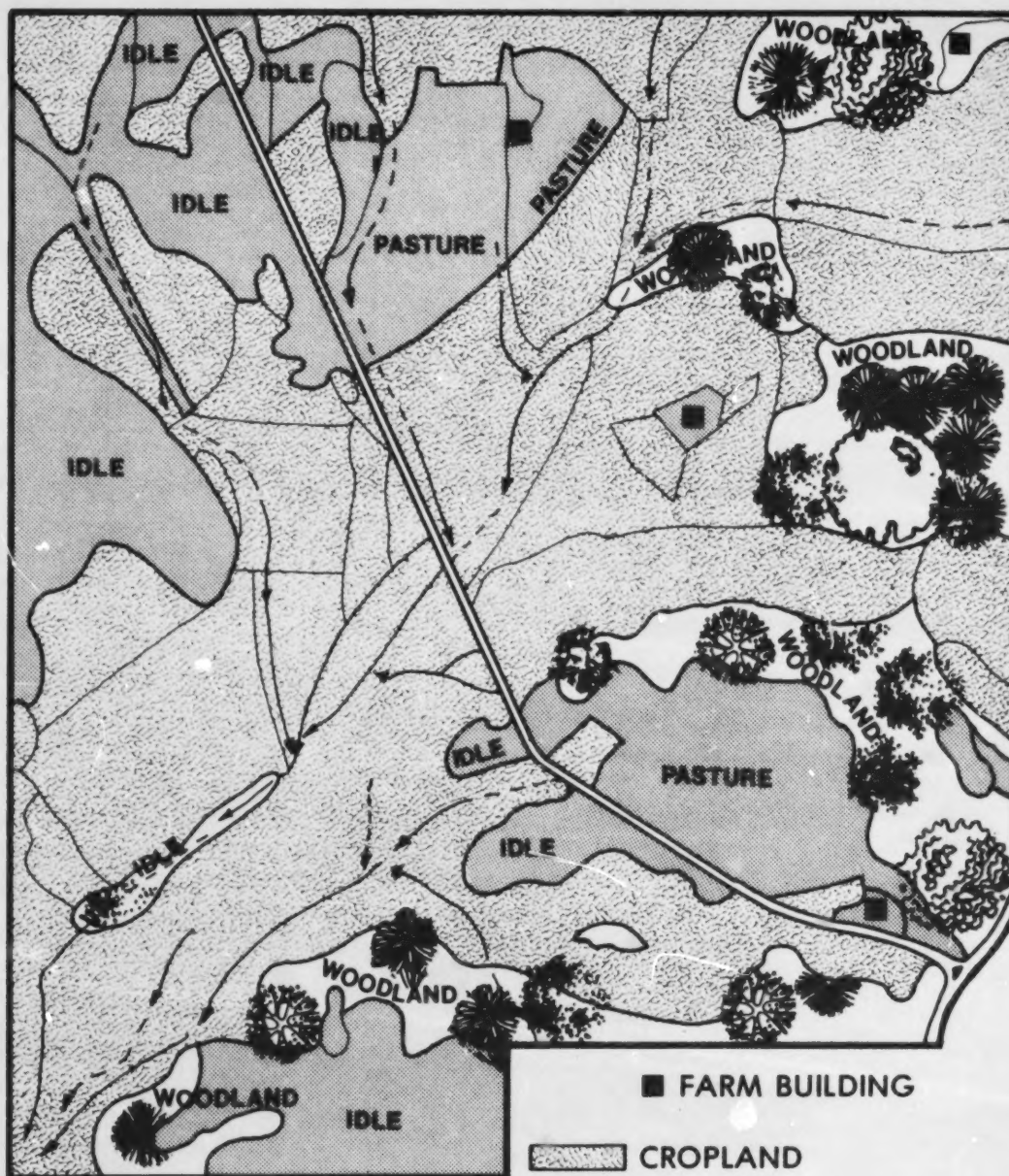
CALLOWAY SILT LOAM. Nearly level to gently sloping land with slight to moderate erosion. Shallow, cold, and somewhat poorly drained soil.

Example No. 2 **Vle2 - 40D3.**

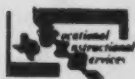
GRENADA SILT LOAM. Steep land with severe erosion. Soil is moderately deep to a pan and is moderately well drained.



ORIGINAL LAND USE MAP



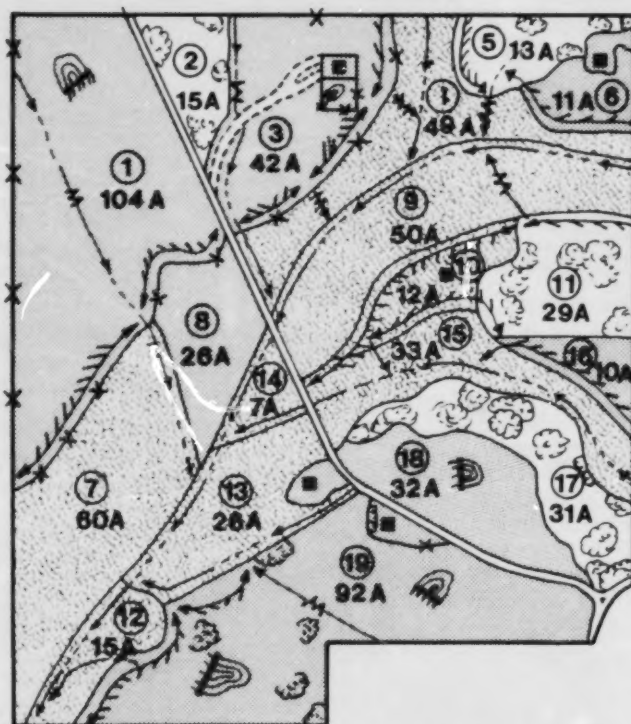
← --- DRAINAGE MAINS AND LATERALS



V. A. III

III-A-2
No. 4

PROPOSED LAND USE MAP

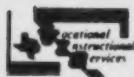


PUBLIC ROAD
 FARM BUILDING
 FENCE
 FIELD BOUNDARY
 APPROXIMATE ACREAGE
 DRAINAGE MAINS
 AND LATERALS
 GRASSED WATERWAY
 DIVERSION
 POND WITH DAM
 CROPLAND: FIELDS 4, 7, 9, 10, 12, 13, 14 15
 CROPLAND
 PASTURELAND: FIELDS 1, 3, 19
 WOODLAND: FIELDS 2, 5, 11, 17
 WILDLIFE LAND: FIELD 8
 HAYLAND: FIELDS 6, 16, 18

RECORD OF COOPERATIVE DECISIONS BETWEEN LAND OWNER AND SOIL CONSERVATIONIST

Examples:

FIELD	ACREAGE	USE	CONSERVATION TREATMENT
2	15	Woodland	Establish full stand of loblolly pine. Exclude livestock. Keep out fire.
8	26	Wildlife	Each year grow brown top millet in cultivated rows for doves and allow hunting in season for income. Plant about 70 days before hunting season. Fertilize with 500lbs. of 6-12-6 per acre.



SOIL SCIENCE

Unit A: Reading and Interpreting Soil Maps

Topic 3: The Use of Soil Maps

Suggested Procedures and Activities: Copies of a farm or ranch conservation plan are ideal teaching aids to use in completing this soil science topic. The plan ~~can~~ be obtained directly from the farmer/rancher or borrowed from the district or local soil conservationist.

Note: All terms underlined are included in the "Glossary of Terms" at the end of this topic.

1. Using Soil Map Information

Soil map information is useful to all people directly or indirectly. The primary purpose of making soil surveys is to plan for the nation's agricultural future. The nation cannot prosper without food; most food can come only from soil; soil has to be protected; protecting the soil is possible only by studying detailed information concerning it. Few soils are economically productive just as they are. Many of our most productive soils have been made so through the farmer's applied knowledge. Soil surveys or maps provide the basic information for this work.

The Soil Conservation Service provides technical assistance to landowners based upon results of soil surveys. Soil Conservation technicians help landowners plan the use of their soils for maximum use and productivity. Technical information is recorded in a written plan called a "Soil and Water Conservation Plan."

2. Farm and Ranch Conservation Plans

Farm or ranch soil and water conservation plans are developed with landowners through assistance furnished by technicians from the Soil Conservation Service. These plans reflect landowners' decisions based on sound land uses and economy of operations. The Soil and Water Conservation Districts recognize the importance of conservation of soil, water, and plant resources for both public and private interests and believe more effective use of our resources can be brought about by adequate planning.

A conservation plan will consist of a proposed plan map of the individual farm and a soil survey map. The farmer's decisions on how to use the land are recorded by the technician. A cooperative agreement between the farmer and the District will be signed. All these documents will be combined in a folder and will serve as a conservation plan for the guidance of the farmer or cooperator.

Transparency No. 1

The cover of the folder containing the technical information making up the Soil and Water Conservation Plan would identify the farm cooperator and the conservation district assisting with the plan.

Transparency No. 2

An aerial photograph map shows the location of the property and the purposes for which the land is being used. The legend for the symbols used on the map is located at the bottom of the page. Map boundaries are shown with the number of acres recorded for each separate plot.

Transparency No. 3

The capability groups are shown in the aerial photograph map with the proper symbols designating the various soil phases. The legend below the map gives the suitability groups for areas being used for pastureland and hayland and the capability unit for the area used for cropland. Note the dark lines separating the capability units.

Transparency No. 4

(Refer to Transparency No. 2 - plot 2, Pastureland - 75 acres)

This record shows the field number and number of acres for location on the soil map. Also, it describes planned activity and applied activity with the year of planning and completion.

The suggested management practices are listed under the column "Land Use and Treatment." This example shows brush control by chemical and mechanical applications, overseeding of vetch on permanent bermuda pasture, controlled grazing, and fertilization.

Transparency No. 5

(Refer to Transparency No. 2 - plot 1, Cropland - 25 acres)

Note the land use and treatment practices are recommended to be carried out each year except for special jobs such as terrace gradient and grassed waterway. Planned yearly activities include a conservation cropping system, crop residue management, and contour farming - with specific suggestions for each.

Transparency No. 6

(Refer to Transparency No. 2 - plots 3, 4, and 5, Wildlife - 31 acres)

Note these areas (designated No. 3 - 5 acres, No. 4 - 15 acres, and No. 5 - 11 acres) are all wooded areas. The land use and treatment recommendations are to maintain existing brush and trees, food, and cover plants for deer and squirrel. The recommendations also call for protection from fire and overgrazing.

Transparency No. 7

The annual grazing plan in this example is for a cow-calf type enterprise. Animal units on the land are 25, and the number of planned animal units for the year is also 25. The entire 75 acres is used for year round grazing. Spaces are also provided to record the estimated amount of hay and protein supplement needed to winter the cattle.

Transparency No. 8

The forage inventory would indicate to the farmer or rancher the amount of forage that would be produced from the pasture or hayland. In this example, the 75 acres of pasture land produced a total of 300 tons. Under the separate monthly columns, figures indicate the estimated amount of forage produced each month. Notice the winter months produced little or no forage, and these were the months the cattle had to be fed hay and protein supplement as indicated on the grazing plan.

Transparency No. 9

A Farmer-District Cooperative Agreement should be used with the soil and water conservation plan. It indicates in writing the conditions and responsibilities to be met by both the Soil Conservation District and the farmer. After agreeing upon these conditions, both parties sign the agreement.

3. Value of Soil Map Information

Soil map information can help plan for short-and long-term investment with the landowner's management plans. Farmers or ranchers can plan long-term investment by the needs plotted on the maps. They know or will find terracing, drainage systems, and leveling for irrigation are costly, and the returns will only show up after several years. They can change crops, land use, or prevent decline in crop yields to reduce expenses. Changes they make should bring a higher net income.

Soil management can be limited by the amount of capital the landowners can secure. Short-term investments are more interesting to bankers than long terms. In practicing soil and water conservation through use of soils maps, landowners protect and improve the land resource base of the nation and add to the economic structure of their communities.

References:

1. "District Program and Work Plan," Wharton County Soil Conservation District, No. 342, Wharton, Texas, 1959.
2. Donahue, Roy L., Raymond Miller, and John Shickluna, Soils - An Introduction to Soils and Plant Growth, 4th ed., Prentice - Hall, Inc., Englewood Cliffs, New Jersey, 1977, pp. 457-459.
3. "Program and Plan," Brazos - Robertson Soil Conservation District, No. 431, Bryan, Texas, 1964.
4. Soil Survey - Bexar County, Texas, Series 1962, No. 12, U.S. D. A., S. C. S., Texas Agricultural Experiment Station, June, 1966.
5. Soil Survey - Brazos County, Texas, Series 1951, No. 1, U.S. D. A., S. C. S., Texas Agricultural Experiment Station, June, 1958.
6. Soil Survey of Bowie County, Texas, U.S. D. A., S. C. S., Texas Agricultural Experiment Station, October, 1980.
7. Soil Survey of Harris County, Texas, U.S. D. A., S. C. S., Texas Agricultural Experiment Station, Harris County Flood Control District, August, 1976.
8. Soil - The Yearbook of Agriculture - 1957, U.S. D. A., Washington, D. C., pp. 400-425.
9. Stallings, J. H., Soil Conservation, 1st ed., Prentice - Hall, Inc., Englewood Cliffs, N. J., 1957, Chapter 7, pp. 424-448.
10. "What Is A Farm Conservation Plan?", United States Department of Agriculture, Soil Conservation Service, PA - 629.

GLOSSARY OF TERMS

Forage - plant material used as feed by domestic animals. Forage can be grazed or cut for hay.

Grassed waterway - a natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. A grassed waterway conducts surface water away from cropland.

Soil and water conservation - the efficient use and stability of soil and water needed for use at optimum levels according to the specific patterns of soil and water resources on individual farms, ranches, forests, and other land management units. The term includes the positive concept of soil and water improvement for use as well as protection and preservation.

Soil management - the preparation, manipulation, and treatment of soils for the production of plants, including crops, grasses, and trees.

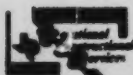
Terrace - an embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so water can soak into the soil or flow slowly to a prepared outlet. A terrace in a field is generally built so the field can be farmed. A terrace intended for drainage has a deep channel maintained in permanent sod.

**SOIL AND WATER
CONSERVATION PLAN**

COOPERATOR

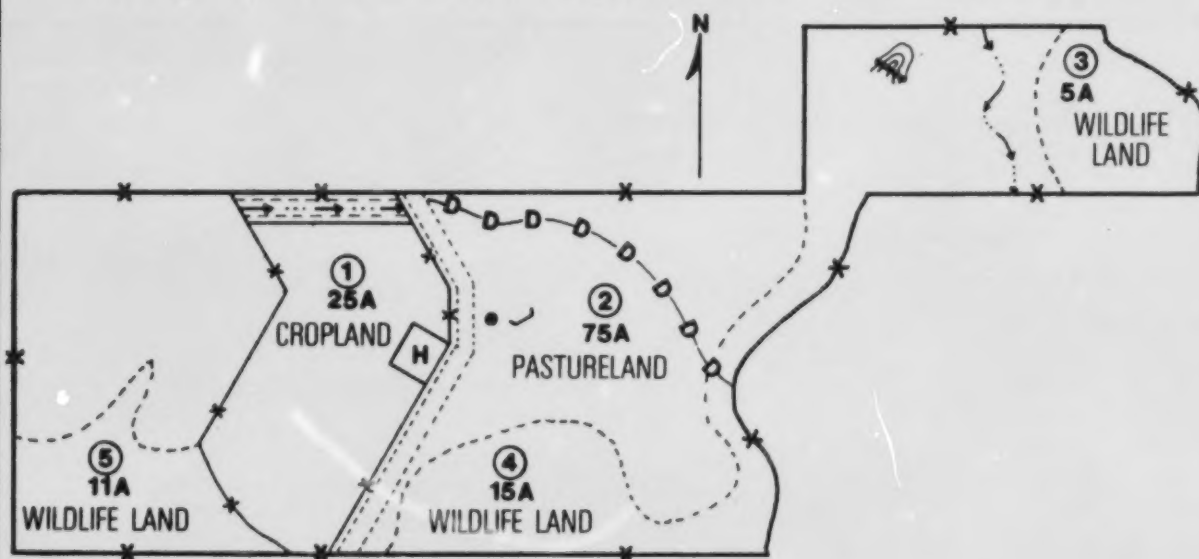
CONSERVATION DISTRICT

**Assisted by
UNITED STATES DEPARTMENT
OF AGRICULTURE
SOIL CONSERVATION SERVICE**



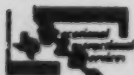
CONSERVATION PLAN MAP

COOPERATING WITH _____ SOIL CONSERVATION DISTRICT
 OWNER _____ OPERATOR _____
 COUNTY _____ STATE _____ ACRES _____ APPROX. SCALE
 DATE PREPARED _____ PHOTO NOS. _____ " = 1 MILE



LEGEND FOR FARMS

FARM OR RANCH ROAD	=====	DIVERSION	-D-D-D-
FENCE	-x-x-	VEGETATIVE WATERWAY	~~~~~
LAND USE BOUNDARY	-----	WELL	•
POND	⊖	WATER TROUGH	⌒
FARMSTEAD	H	STREAM	~~~~~
FIELD NO.	③	NO. OF ACRES	17A



V. A. III

III-A-3
No. 2

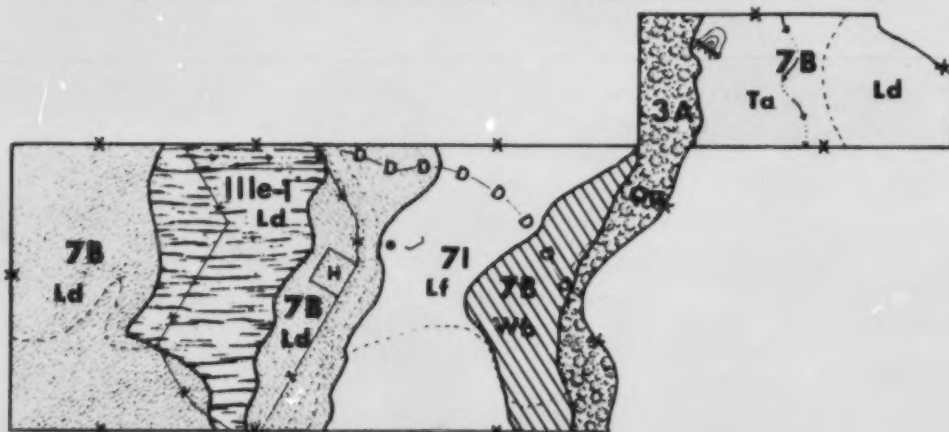
SOIL AND CAPABILITY MAP

PREPARED BY U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION
SERVICE, COOPERATING WITH _____ SOIL CONS. DIST.

OWNER _____ OPERATOR _____

COUNTY _____ STATE _____ DATE SURVEYED _____

PHOTO NO. _____ APPROX. SCALE _____"=1 MILE



PASTURELAND AND HAYLAND

SUITABILITY GROUPS

BLACKLAND PRAIRIE

7B Ld- LUFKIN FINE SANDY LOAM, 1-3% SLOPES

Ta- TABOR FINE SANDY LOAM, 1-3% SLOPES

Wb- WILSON CLAY LOAM, 1-3% SLOPES

HEAVY CLAYEY UPLANDS, SLOPING TO STEEP, MODERATE
INHERENT FERTILITY, MEDIUM TO HIGH PRODUCTION POTENTIAL.

71 Lf- LUFKIN EDGE COMPLEX, 3-8% SLOPES

TIGHT CLAYEY UPLANDS, SLOPING TO STEEP, TIGHT
SUBSOILS, MEDIUM INHERENT FERTILITY, MEDIUM
PRODUCTION POTENTIAL.

EAST TEXAS TIMBERLANDS

3A Oa- OCHLOCKONEE FINE SANDY LOAM

DEEP SANDY BOTTOMLAND, OPEN SUBSOIL, MAY OVERFLOW,
LOW INHERENT FERTILITY WITH MEDIUM TO HIGH
PRODUCTION POTENTIAL.

CAPABILITY UNITS (CROPLAND)

EAST TEXAS TIMBERLANDS

IIIe-1 Ld- LUFKIN FINE SANDY LOAM, 1-3% SLOPES

DROUGHTY, GENTLY SLOPING, MODERATELY EROSION,
CLAY LOAMS TO SANDY LOAMS WITH VERY SLOWLY
PERMEABLE SUBSOILS. SURFACE MAY HAVE MOUNDS.



V. A. III

III-A-3

No. 3

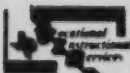
COOPERATOR _____

ASSISTED BY _____

DATE _____

RECORD OF COOPERATOR'S DECISIONS AND PROGRESS IN APPLICATION

FIELD NUMBER	PLANNED		APPLIED		LAND USE AND TREATMENT
	AMOUNT	YEAR	AMOUNT	MONTH AND YEAR	
					Pastureland 75 Acres Cropland 25 Acres Wildlife Land <u>31 Acres</u> Total 131 Acres
2	75Ac				PASTURELAND
2	75 Ac	1981 1987			BRUSH CONTROL - CONTROL MESQUITE BY USE OF CHEMICALS. DOZE, PILE, AND BURN SCATTERED OAK AND ELM. LEAVE A FEW LARGE TREES FOR SHADE.
2	75 Ac	1981 1984			PASTURE PLANTING - OVERSEED PASTURES WITH VETCH TO IMPROVE STAND OF COMMON BERMUDA GRASS. FERTILIZE AND DISK LAND TO HELP SPREAD BERMUDA GRASS.
2	75 Ac	EACH YEAR			PASTURE MANAGEMENT - CONTROL GRAZING BY LIVESTOCK TO MAINTAIN 4 INCHES OF STUBBLE HEIGHT ON COMMON BERMUDA. FERTILIZE EACH YEAR WITH 300 LBS. 16-6-12 FERTILIZER OR USE RESULTS OF SOIL TESTS. CON- TROL WEEDS BY SHREDDING.
2	75 Ac				LAND ADEQUATELY TREATED



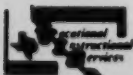
COOPERATOR _____

ASSISTED BY _____

DATE _____

RECORD OF COOPERATOR'S DECISIONS AND PROGRESS IN APPLICATION

FIELD NUMBER	PLANNED		APPLIED		LAND USE AND TREATMENT
	AMOUNT	YEAR	AMOUNT	MONTH AND YEAR	
1	25 Ac				CROPLAND
1	25 Ac	EACH YEAR			CONSERVATION CROPPING SYSTEM- PLANT A MINIMUM OF 2/3 OF THE LAND EACH YEAR IN A HIGH RESIDUE CROP SUCH AS CORN. PLANT 1/3 OF THE LAND EACH YEAR TO SOIL IM- PROVING CROPS SUCH AS SUMMER PEAS. FERTILIZE HIGH RESIDUE CROPS TO PRODUCE 4,000 LBS. DRY WEIGHT OF RESIDUE TO RE- TURN TO THE LAND.
1	25 Ac	EACH YEAR			CROP RESIDUE MANAGEMENT - SHRED CORN STALKS AND LEAVE ON OR NEAR THE SOIL SURFACE DURING FALL MONTHS OF THE YEAR FOR PROTECTION AGAINST EROSION.
1	6,150 ft.	1981			TERRACE GRADIENT - REBUILD OLD TERRACES TO GRADE AND SPACING DETERMINED AT TIME OF LAYOUT.
1	25 Ac	EACH YEAR			CONTOUR FARMING - CARRY OUT ALL FARMING OPERATIONS PARALLEL TO TERRACE SYSTEM.
1	1 Ac	1981			GRASSED WATERWAY - APPLY FERTI- LIZERS AND DISK TO SMOOTH EXISTING WATERWAY.
1	25 Ac				LAND ADEQUATELY TREATED



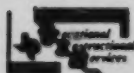
COOPERATOR _____

ASSISTED BY _____

DATE _____

RECORD OF COOPERATOR'S DECISIONS AND PROGRESS IN APPLICATION

FIELD NUMBER	PLANNED		APPLIED		LAND USE AND TREATMENT
	AMOUNT	YEAR	AMOUNT	MONTH AND YEAR	
3, 4, 5	31 Ac				WILDLIFE LAND
3, 4, 5	31 Ac				WILDLIFE HABITAT MANAGEMENT - MAINTAIN EXISTING BRUSH AND TREES, FOOD, AND COVER PLANTS FOR DEER AND SQUIRREL. PROTECT FROM FIRE AND OVERGRAZING.
3, 4, 5	31 Ac				LAND ADEQUATELY TREATED



ANNUAL GRAZING PLAN

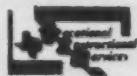
Cooperator _____ Type of enterprise (cow-calf, dairy, stocker, etc.) Cow-calf
 Technician _____ Animal units on hand now 25 Est. No. of game animals _____
 Date _____ Planned animal units this year 25

Field or Pasture No.(s) Kind of Forage	Acres	(By months, show planned no. of animals in each grazing unit)											
		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
2. <i>Common Bermuda</i>	75	25	25	25	25	25	25	25	25	25	25	25	25
Total	XXX	25	25	25	25	25	25	25	25	25	25	25	25
Feed	Hay	2T.	3T.	2T.									1T.
	Protein Suppl.	1¼T.	1¼T.	1T.									½T.

FORAGE INVENTORY

Cooperator _____ Technician _____ Date _____

Field or pasture No.	Kind of Forage and Production Factors	Acres	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
2	<i>Common Bermuda</i>	75	0	0	25	40	40	40	40	25	40	40	10	0	300T.
	Total	XXX	0	0	25	40	40	40	40	25	40	40	10	0	300T.
Feed:	Hay														
	Protein Suppl.														



253

V. A. III

III-A-3

No. 8

254



SOIL CONSERVATION DISTRICT



Farmer-District Cooperative Agreement

THIS AGREEMENT IS ENTERED INTO BY THE _____ SOIL CONSERVATION DISTRICT, REFERRED TO HEREINAFTER AS THE "DISTRICT", AND

REFERRED TO HEREINAFTER AS THE "FARMER".

THE DISTRICT AGREES TO:

ASSIST IN CARRYING OUT A CONSERVATION PLAN BY FURNISHING TO THE FARMER SUCH (1) INFORMATION, (2) TECHNICAL ASSISTANCE AND SUPERVISION, AND (3) OTHER ASSISTANCE AS IT MAY HAVE AVAILABLE AT THE TIME THE WORK IS TO BE DONE.

THE FARMER AGREES TO:

1. USE THE LAND WITHIN ITS CAPABILITIES.
2. TREAT THE LAND IN KEEPING WITH ITS NEEDS.
3. DEVELOP AS RAPIDLY AS FEASIBLE A CONSERVATION PLAN FOR THE ENTIRE FARM.
4. START APPLYING ONE OR MORE CONSERVATION PRACTICES IN KEEPING WITH THESE OBJECTIVES AND THE TECHNICAL STANDARDS OF THE DISTRICT.
5. MAINTAIN ALL STRUCTURES ESTABLISHED IN AN EFFECTIVE CONDITION AND TO CONTINUE USE OF ALL OTHER CONSERVATION MEASURES PUT INTO EFFECT.
6. USE ANY MATERIALS OR EQUIPMENT MADE AVAILABLE BY THE DISTRICT FOR THE PURPOSE AND IN THE MANNER PROVIDED FOR IT.

IT IS FURTHER AGREED THAT:

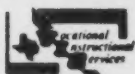
1. THIS AGREEMENT WILL BECOME EFFECTIVE ON THE DATE OF THE LAST SIGNATURE AND MAY BE TERMINATED OR MODIFIED BY MUTUAL AGREEMENT OF PARTIES HERETO.
2. THE PROVISIONS OF THIS AGREEMENT ARE UNDERSTOOD BY THE FARMER AND THE DISTRICT AND NEITHER SHALL BE LIABLE FOR DAMAGE TO THE OTHER'S PROPERTY RESULTING FROM CARRYING OUT THIS AGREEMENT UNLESS SUCH DAMAGE IS CAUSED BY NEGLIGENCE OR MISCONDUCT.

WITNESS THE FOLLOWING SIGNATURES:

(WITNESS) (DATE) (OWNER)

SOIL CONSERVATION DISTRICT

DATE _____ BY _____



SOIL SCIENCE

Unit B: Managing Soils

Topic 1: Basic Considerations for Soil Management

Suggested Procedures and Activities: A field trip through the local community to view many of (or a lack of) the soil management practices listed on Transparency No. 1 would be an ideal teaching aid for this topic.

Note: All terms underlined are included in the "Glossary of Terms" at the end of this topic.

1. Introduction

Land is what we live on. It is the foundation of the environment that shapes our lives. Our ability to adapt to our environment determines the level of civilization we attain. We have food to eat, clothes to wear, houses to live in, and health to enjoy because we have made good use of the land. Only when we are fed, clothed, housed, and healthy do we have the time and energy for tasks that will raise our standard of living and create from our environment a higher civilization. Luxuries are possible only after the necessities of life have been assured.

But our American land is being divided and divided again for the multiple needs of a nation growing rapidly in population, urban development, highway mileage, and in an array of human-oriented uses alien to nature. Our American land that once seemed so limitless is shrinking before us at every turn - and we are made aware of a challenging crisis. Land uses are changing, and therein lies the crisis - are these changes right for our land and for us?

Civilization is based on the productivity of the land, and the United States is fortunate in having had abundantly fertile land to begin with. Productivity depends on the rich natural endowment of land and also on the skill and technology with which people use it.

George Washington once said, "Nothing in my opinion would contribute more to the welfare of the states than proper management of the lands."

2. Soil Management

Good farm management consists of organizing and using all of the soil on the farm in accordance with sound conservation principles in order to yield the maximum continuous profit. All of the land is included because non-tillable woodlands and pastures, when properly managed, produce income, provide watersheds, and control drainage.

Only a few soils in their natural state are ideally suited to crop plants. Most soils require considerable change in their chemical, physical, and biological characteristics that influence the nutrient and water supplies for growing plants. Soils with desirable soil characteristics respond well to management while those having poor characteristics will not.

Transparency No. 1

Once a good arable soil has been developed, soil management practices are designed to maintain and improve it.

Soil productivity can be maintained by recognizing the importance of these practices and properly using them to meet the particular needs of each farm.

For example, there would be little need to irrigate soils if sufficient fertilizers and improved varieties were not used to obtain optimum yields. In areas subject to winds of high velocity, the surface of cultivated soil needs to be cloddy and trashy to help prevent blowing of the fine particles. Permanent vegetation must be established and maintained on soils highly susceptible to soil blowing. Sloping, erosive soils in regions of high rainfall intensity need full protection by vegetation to intercept the force of raindrops.

3. Who Should Pay for Conservation?

Conservation, like some other well advertised products, doesn't cost - it pays. Yet the benefits may be so delayed and so dispersed that the person who pays the cost is not the chief beneficiary. This is a conservation dilemma: Who should pay for work done on private land that is essential to survival of the race?

The nation must look to the owners and managers of private agricultural land for most of its conservation work. Private land produces virtually all of our food and most of our fiber. Nearly three-fifths of the nation's land area is privately owned rural land. A high percentage of this land is in crops, pasture, range, or other non-forest agriculture. The most highly urban populations, whether they realize it or not, must look to farmers and ranchers for protection of their basic resources.

Transparency No. 2

Based on an evaluation of the national conservation needs inventory of 1958-60, the U.S. Department of Agriculture estimated a "conservation need" for the investment of \$2.4 billion a year on agricultural lands. This was the amount required to do the necessary conservation job.

At present, we have invested only about 40% of that amount of money. The U.S.D.A. estimated our total conservation investment by individuals and the

public (but not including forest conservation by the timber industry) to be about one billion dollars a year. Our investment has increased very little since 1958-60, particularly when measured against the rising costs of conservation service and materials.

Transparency No. 3

A comparison of the conservation needs inventory of today with the conservation needs inventory of 1958-60 indicates accomplishments since those years have provided only a reasonably effective holding action. In some areas we have actually lost ground.

The results are plain:

Almost two-thirds of our present cropland still needs conservation treatment.

Almost two-thirds of our privately owned pasture and rangeland needs conservation treatment.

More than three-fifths of our private forest and woodland needs conservation treatment.

Pollution of our waters is so common that we take for granted the "unsafe" signs that mark once-wholesome swimming waters. Formerly clean streams are loaded with sediment from rural and urban lands, if not actually poisoned with sewage or chemicals. This makes them virtually unsafe for recreation and agricultural uses.

Why are we failing? The answer boils down to the non-esthetics of money: How to get it, who provides it, how you spend it, and what you give up in order to make these funds available.

We have the technical know-how to do the farm conservation job. This knowledge is in the hands of conservationists in every farm county of America. Generally speaking, farmers no longer neglect the land because they cannot get needed technical help. Today, its mostly a question of economics.

4. Who Does Pay For Conservation?

Who pays for work that may add to a farmer's long-run income but also preserves the nation's ability to produce? Who pays for practices that do nothing for a farmer's income, yet add beauty to the countryside?

Who pays for measures that send clean water into city reservoirs?

Who pays to insure the propagation of wildlife in a nation that continues to value the "free hunting and fishing" ethic of its frontier days?

Transparency No. 4

It can be argued that somebody pays for conservation whether it is done or not.

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GLOSSARY OF TERMS

Arable soil - soil that is tilled or tillable.

Cloddy - a descriptive term relating to a clod. A clod is a compact mass of soil ranging in size from 2/10 to 10 inches (5 to 250 mm) produced artificially by plowing clay soils when too wet or too dry.

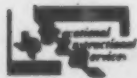
Esthetic (or Aesthetic) - appreciative of the beauty of something.

Soil characteristic - a feature of soil seen and/or measured in the field or laboratory. Some of these soil characteristics include soil slope, stoniness, texture, structure, color, and chemical composition.

Watershed - in the U.S., the term refers to the total area above a given point on a stream that contributes water to the flow at that point. In some countries, it is the topographic boundary separating one drainage basin from another.

SOIL MANAGEMENT PRACTICES

- ✧ EROSION CONTROL
- ✧ WATER CONSERVATION AND USE
- ✧ DRAINAGE
- ✧ MAINTENANCE OF DESIRABLE SOIL REACTION (pH)
- ✧ ADDITIONS OF PROPER PLANT NUTRIENTS
- ✧ CROPPING PRACTICES
- ✧ TILLAGE PRACTICES
- ✧ ORGANIC MATTER REPLENISHMENT



**COMPARISON OF CONSERVATION
NEEDS AND EXPENDITURES
ON AGRICULTURE LAND ANNUALLY
U.S. Department of Agriculture**

1958-60 NATIONAL CONSERVATION NEEDS INVENTORY

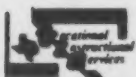
Estimated:

\$ 2.4 billion-conservation needs

TODAY ESTIMATED TOTAL CONSERVATION INVESTMENT

\$ 1 billion-conservation investment

(ABOUT FOUR-TENTHS OF CONSERVATION NEED)



A CONSERVATION NEEDS INVENTORY

THIS INVENTORY REFLECTS:

- ▶ Almost two-thirds of our present cropland still needs conservation treatment.
- ▶ Almost two-thirds of our privately owned pasture and rangeland needs conservation treatment.
- ▶ More than three-fifths of our private forests and woodlands need conservation treatment.



POLLUTION OF OUR WATERS HAS MADE THEM VIRTUALLY
UNSAFE FOR RECREATION AND AGRICULTURAL USES.

WHO PAYS FOR CONSERVATION?

IF THE WORK IS NOT DONE—

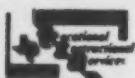
Society pays through rising costs for:

1. WATER PURIFICATION
2. REHABILITATION OF RESERVOIRS
3. DREDGING OF RIVERS AND HARBORS
4. BUILDING COSTS OF HIGHER LEVEES
5. FUTURE CROP SHORTAGES
6. HIGHER FOOD COSTS
7. A DEGRADED ENVIRONMENT
8. DYING LAKES AND ESTUARIES
9. LOSS OF WILDLIFE
10. ANY NUMBER OF ESTHETIC VALUES

IF THE WORK IS DONE—

Paid for predominantly by the owners and operators of farm and ranch land.

The current annual conservation investment is about \$ 1 billion and about one-third is paid by the federal government. Most of the other two-thirds is invested by the owners of the land.



SOIL SCIENCE

Unit B: Managing Soils

Topic 2: Economic Importance of Soil Management

1. Introduction

Today we appear to have an economic paradox in our country: Federal funds, on one hand, are spent to make our acres more productive and, on the other hand, to store and/or export surpluses. To the average American this doesn't make sense.

Nevertheless, the assurance of plentiful food in the future is a legitimate matter for public concern. Our nation can never afford to have a food shortage; just a rumor of a shortage of food would immediately cause prices to skyrocket beyond reach of the masses of our people. In addition, food exports are essential if we are to help countries feed their hungry populations. Foreign exports are necessary to achieve national security and world peace.

Transparency No. 1

U.S. population is estimated to reach 300 million people by the year 2000. This implies a need for at least 50 percent more food, at least 50 percent more housing, twice as much water, and three times the demand for outdoor recreation. There may be a tripling of the amount of land used for homes, schools, and factories, and more than a doubling of land used for transportation. This means the remaining acres will have to produce more than ever before. A high U.S. population projection of 400 million by 2010 and an increased foreign demand for food will require as much as 200 million acres of additional crop land.

This will be the period when our conservation of resources will become even more critical; we may be farming land on steep slopes much less fertile than the land we are farming now - the type of farming one sees in Italy, Japan, China, or in any other heavily populated country. The conservation of our soil and water, therefore, becomes everyone's business because everyone eats food and drinks water.

2. Can and Will Farmers and Ranchers Sharply Increase Their Investment In Land and Water Conservation?

Many people still reflect a traditional view that landowners should pay the entire cost of work done on their cropland and pastures. But even if you accept this as a philosophical argument, you still have to answer the practical question - Can the conservation needs of the nation be met solely by farmers and ranchers?

Transparency No. 2

If farmers and ranchers are to do this, the increased investment must come out of their income and predominantly out of their net income.

In 1980, 1.3 million or 57% of America's 2.3 million farms produced a gross income of less than \$20,000. These farms realized only 7% of total cash receipts and 14% of total net income.

The remaining one million larger farms (those grossing \$20,000 or above) control a large land area, 93% of total cash receipts, and 86% of total net income. In fact farms with sales over \$200,000 represent only 3% of all farms, but they account for 43% of total cash receipts and 20% of total net income. But even these farmers must contend with the high cost and uncertainty that prevail in agriculture. They must also produce in a highly cost-competitive economy where conservation work may produce smaller immediate returns than other capital investments.

Figures for 1980 showed the average size of our farms to be 453 acres; farmers sold livestock and crops valued at \$58,000 per farm; and their average net income was \$11,500 a year.

For their labor, capital, and management to the farm, they received \$4,604 of personal income per person on the farm. They also received an average of \$4,261 of personal income from non-farm sources.

Will farmers and ranchers increase their investment in conservation needs? Experience shows us that landowners assign a low priority to conservation investment in relation to some of the other immediate operating costs.

Farmers and ranchers are now investing about 4 to 6 percent of their net farm income in soil, water, pasture, and forest conserving measures. While the conservation of our agricultural resources must be carried out through the farm family, the farm family does not generally have the financial means to do conservation work on the scale we now consider necessary. The average farmer cannot be expected to carry alone the total burden of conservation that needs to be done.

Farmers and ranchers realize that conservation is desirable - socially, esthetically, and economically - yet they have a prior responsibility: to feed their families and provide them with other essentials of modern living.

The public, then, must be realistic in assessing its own environmental needs and its obligation to help meet these needs in the indefinite future. There can be no question that public and private demands on natural resources will continue to grow rapidly - a growth related to the rise in population, the growth of industry and urbanization, rising levels of living, and expanded leisure time.

Conservation can no longer be viewed as an independent and individual problem. It is a problem of society in the framework of education, research, production, credit, tax base, and all other branches of a great society. The metropolitan centers must be brought into the picture. The problem is equally urban and rural. The approach must be on an American and on a community basis. All people working together for the common good, as a group, and not as individuals.

3. Factors of Income

Farmers and ranchers try to select soil-management practices and systems that will give them the highest sustained net income. Usually they are interested in maximum income over a period of years.

An important economic principle that affects soil management is the "diminishing returns" relationship which applies to the amount of additional product obtained as additional inputs of variable factors of production are added to a fixed amount of other factors.

As more of a resource is applied to a given amount of a fixed resource, a point is reached beyond which the additional product obtained per unit of the added resource declines. This is the point of diminishing returns.

Fertilizer application in crop production provides a good illustration of the principle of diminishing returns.

Transparency No. 3

The table portrays grain production with various amounts of fertilizer applied to a "bundle" of fixed factors. The term "bundle" is used for the fixed factors (land, seed, labor, tractor fuel, machine services, and the like) to emphasize that proportions as well as absolute quantities of these factors are held constant. As the amount of fertilizer applied is increased, total production increases, but at a decreasing (diminishing) rate. This is reflected in the decrease in additional production per unit of fertilizer added. The first unit of fertilizer applied increased production 16 hundred weight. However, the second unit applied increased production only 10 hundred weight. Additional production associated with increased applications of fertilizer continues to decline until, finally, the sixth unit of fertilizer produced no increase in output.

Transparency No. 4

The figures from the table can be graphically illustrated to show the point of diminishing returns.

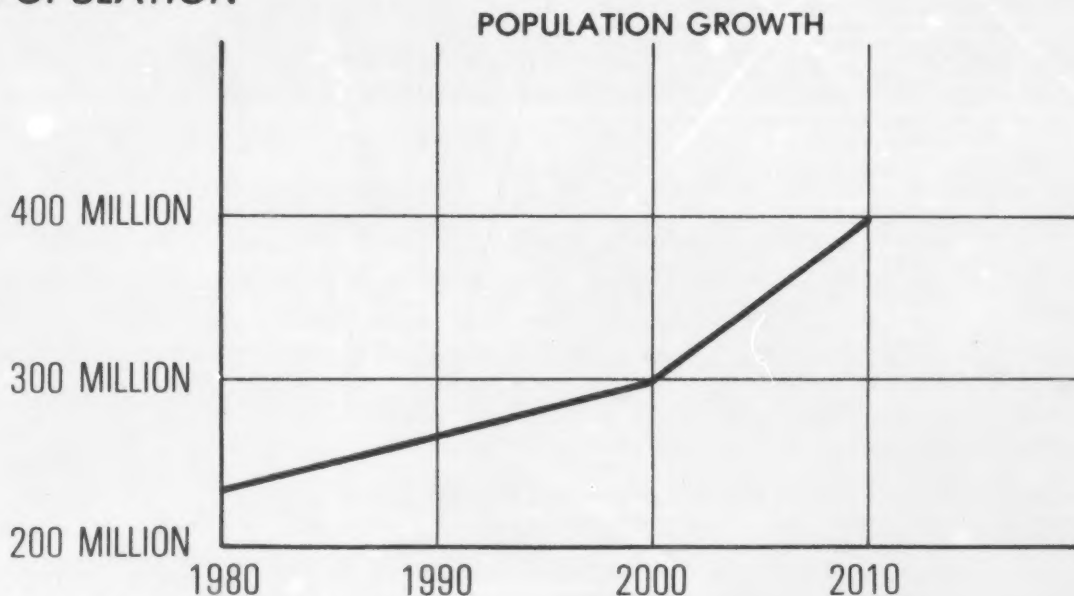
The point of diminishing returns occurs at the highest point on the "total output" curve which coincides with the point on the bottom curve where "additional output per unit of input" equals zero.

References:

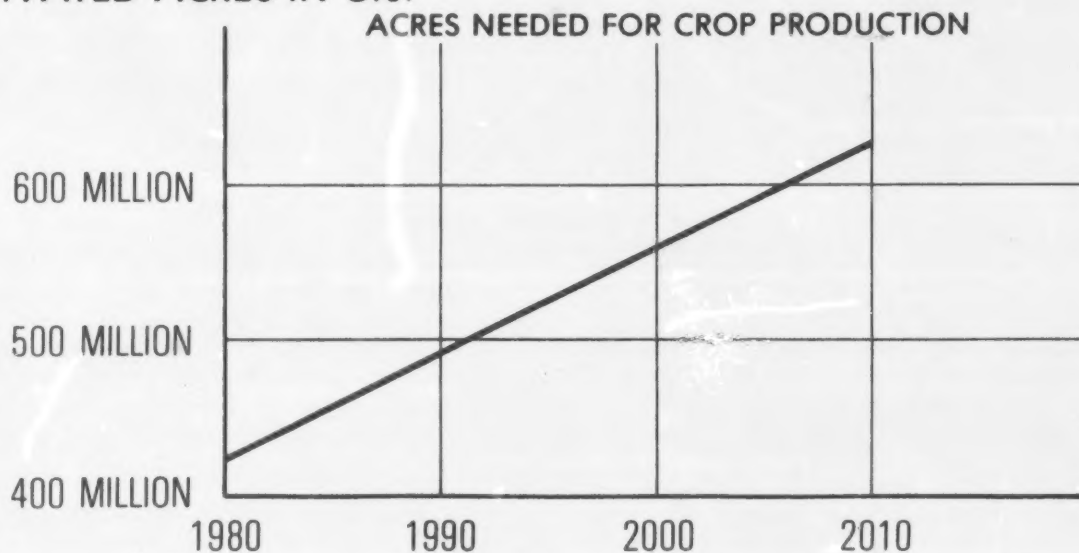
1. Contours of Change - The Yearbook of Agriculture - 1970, U.S.D. A., Washington, D.C., pp. 236-242.
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4. 1980 Handbook of Agricultural Charts, Handbook No. 574, U.S.D. A., Washington, D.C., October, 1980.

ESTIMATED POPULATION AND ACRES NEEDED FOR CROP PRODUCTION BY THE YEAR 2010

U.S. POPULATION



CULTIVATED ACRES IN U.S.



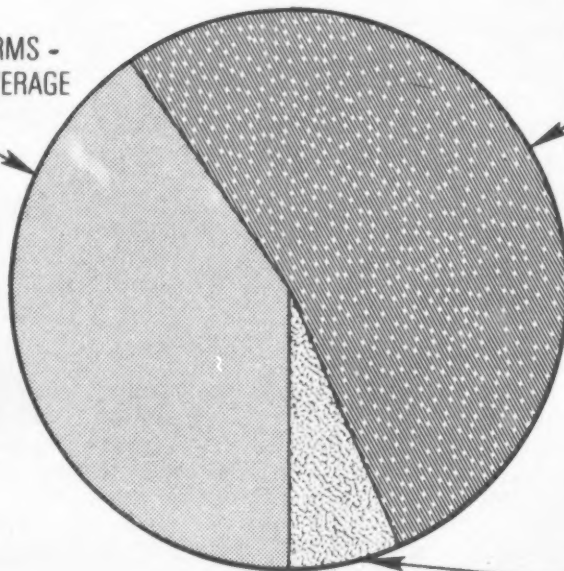
U.S. AVERAGE FARM INCOME - 1980

TOTAL NUMBER OF FARMS=2.3 MILLION

- ★ AVERAGE FARM SIZE IS 453 ACRES
- ★ AVERAGE SALES FROM LIVESTOCK AND CROPS IS VALUED AT \$ 58,000 PER FARM
- ★ AVERAGE NET INCOME PER FARM IS \$ 11,500

57% OR 1.3 MILLION FARMS PRODUCED AVERAGE GROSS INCOME LESS THAN \$ 20,000 ACCOUNTING FOR ONLY 7% OF TOTAL CASH RECEIPTS AND 14% OF TOTAL NET INCOME.

40% OR 0.9 MILLION FARMS - \$20,000 TO \$200,000 AVERAGE GROSS INCOME

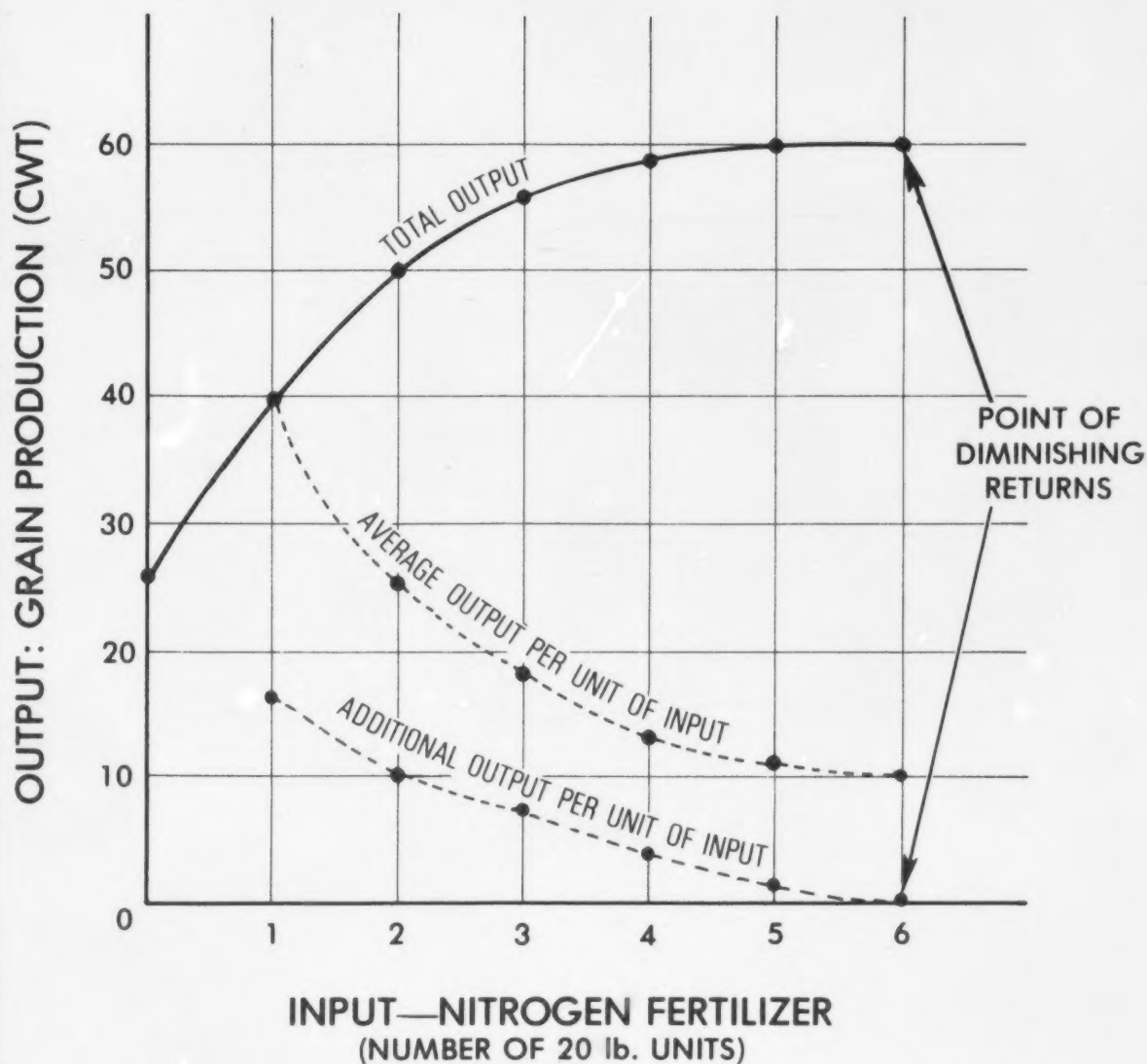


3% OR 0.1 MILLION FARMS-MORE THAN \$200,000 AVERAGE GROSS INCOME ACCOUNTING FOR 43% OF TOTAL CASH RECEIPTS AND 20% OF TOTAL NET INCOME.

GRAIN PRODUCTION RELATED TO VARIOUS LEVELS OF FERTILIZER APPLICATION

INPUTS		OUTPUT: GRAIN PRODUCTION		
FIXED FACTOR	VARIABLE FACTOR: NITROGEN FERTILIZER	TOTAL	AVERAGE PER UNIT OF FERTILIZER	ADDITIONAL PER UNIT OF FERTILIZER
	(NUMBER OF UNITS)	(CWT)	(CWT)	(CWT)
1	0 (NO NITROGEN)	24	...	...
1	1 (20 Lbs.)	40	40.0	16
	2 (40 Lbs.)	50	25.0	10
1	3 (60 Lbs.)	56	18.7	6
1	4 (80 Lbs.)	59	14.8	3
1	5 (100 Lbs.)	60	12.0	1
1	6 (120 Lbs.)	60	10.0	0

GRAIN PRODUCTION RELATED TO VARIOUS LEVELS OF FERTILIZER APPLICATION



SOIL SCIENCE

Unit B: Managing Soils

Topic 3: Managing Soils for Field Crops

Suggested Procedures and Activities: Published soil surveys contain cropland management information which can be used to supplement the information in this topic.

Note: All terms underlined are included in the "Glossary of Terms" at the end of this topic.

1. Introduction

Everyone should have an interest in the care of our soil. Nearly all the food we eat and a large portion of the raw materials for our clothing and shelter are products of the soil. Our population in the United States is largely dependent on nearly one-half billion acres of productive cropland for its very existence. It is a credit to our farmers, agricultural scientists, educators, and those in agricultural business who serve the farmer, that crop yields per acre (hectare) of all major crops have been gradually on the increase.

Transparency No. 1

Not only has the production per acre (hectare) increased, but the production per farm worker has also increased. For instance, in 1850 one farm worker supplied food and fiber for 4 other persons; in 1900, 6 others; in 1950, 15 others; and in 1980, 68 others. Thus, since 1850, the productivity of the average farm worker has increased seventeen fold.

2. Management Practices

Select the best land on the farm for the different field crops. By starting with good land, greater benefits will be obtained from all management practices. This is especially true when the field crops are grown continuously. After proper land selection, good soil management is the next step toward the production of high and profitable yields.

Proper management of soils and water for the efficient production of field crops includes rapid and timely land preparation, use of the best adapted seed, timely spraying of proper chemicals for weed and insect control, and precision planting of seed and placement of fertilizer.

Land Preparation

The preparation of land is a vital part of crop production. Careful attention should be given to methods used, time of year for each operation, and the moisture content of the soil when preparing soils for crops.

Since cultivation or tillage is perhaps the major cause of soil erosion, farmers must understand the objectives and limitations of tillage and recognize it as a great expense. Many farmers have permanently ruined their fields with tillage practices that could not supply the expected benefits.

Transparency No. 2

Objectives of Tillage

The objectives of tillage are temporary soil conditioning, seedbed preparation, planting depth, cultivating row crops, and utilization and disposal of crop residues.

Temporary soil conditioning - Tillage temporarily improves the structure of the soil. Soil pores are increased in size, thus aiding air and water penetration. Soil is more easily penetrated by roots after being tilled.

Seedbed preparation - For a seed to germinate it must have adequate moisture, satisfactory temperature, and a certain amount of oxygen. After a seed germinates, its roots must be able to grow through the soil to secure nutrients and water. Its top growth must be able to break through the crust on the soil surface.

To provide moisture for germination, the seed must have a good contact with moist earth.

Climate is the controlling factor of soil temperature. Seeding dates must be adjusted to insure sufficient warmth.

If moisture conditions are satisfactory, there is usually enough air around the seed for germination. Air supply for downward root growth may become critical, however, even when the surface layers have an adequate supply of oxygen.

Planting depth - Depth of planting is an important consideration. Small seeds such as those of clover and timothy are planted one-half inch to one inch deep; small grains, one to two inches deep; corn, 1-1/2 to 2-1/2 inches deep; and potatoes, three to four inches deep.

Cultivating row crops - Cultivation of row crops conserves moisture, aids aeration, and provides weed control. The operator should keep in mind that the root growth of young plants is often more extensive than top growth. Considerable damage may be caused by deep cultivation.

In general, cultivation should be just frequent enough to control weeds and provide for moisture and air penetration by breaking the surface crust of the soil.

Handling crop residues - Crop residues are a source of organic matter needed for soil maintenance and by proper handling can be made to serve additional purposes. Left on the surface, they prevent soil puddling by protecting the soil from raindrops. In addition, residues slow runoff and surface wind and thus decrease erosion. The practice of mulch tillage for protection against water erosion is also becoming common in the production of row crops.

Transparency No. 3

Tillage Equipment

A variety of tillage equipment is designed to perform such specific tasks as loosening soil, packing soil, breaking up soil, controlling weeds, and covering or breaking up trash. Major categories of tillage equipment include plows, disks, barrows, blade or shovel tillers, and subsurface tillers.

Erosion Control

The continual process of plowing, cultivating, breaking the sod, and growing row crops brings about widespread soil erosion. After every rain, runoff water rushing down unprotected slopes carries with it precious surface soil. Water erosion is removing fertility - in some cases as much as 20 times faster than it is being removed by crops.

Conservation measures such as stabilization of wasteland and grassland farming in areas adjacent to cultivated areas help give cultivated land protection. Within the cultivated lands themselves, additional water and soil conservation measures are needed.

Water may be conserved by increasing water entry into the soil, improving soil water movement, and increasing water storage capacity. Water entry rate may be improved by plowing, contour plowing, mulching, prompt planting, and using cover crops. The amount of water stored by a soil (not its storage capacity) may be increased during cultivation by increasing entry rate and decreasing surface evaporation. It is important to remember that plowing may also restrict the water holding capacity of some soils if a plowpan condition exists.

Soil Detachment by Water Erosion

Soil is eroded by water in two stages: detachment and transportation. Soil particles on bare fields, or those planted with open-growing crops such as corn, are held in place by roots and root fragments, gravity, the filaments of microorganisms, the viscosity (stickiness) of clay particles, electrical attractions, and similar

forces. Before a soil particle can be moved from a location, all these forces must be broken down. In water erosion this is accomplished by either the beating action of raindrops or the force of running water.

Transparency No. 4

The effect of raindrops is known as splash erosion. Falling raindrops act like small bombs. Each time they hit the soil, they dig craters and throw debris. The total energy of raindrops during a rain of one-tenth of an inch per hour is estimated at 100 horsepower. Two inches of rain falling in an hour provides sufficient force to lift a seven-inch layer of topsoil 86 times to a height of three feet.

The second detaching force is running water. The speed at which water flows is controlled by slope and volume and largely determines its detaching force. The effectiveness of moving water in the detachment process is greatly increased by the presence of soil particles in the water. Detachment by running water is confined only to those areas where water is flowing. Raindrop detachment thus tends to loosen soil particles uniformly over a field; running water detachment is confined to rills, gullies, and streams.

Transparency No. 5

Common Types of Water Erosion Resulting in Soil Deposition

Sheet erosion - A fairly uniform layer of soil is removed from an entire surface area. This is caused by splash from raindrops.

Rill erosion - Small channels are cut by water running in very small streams over the surface of the soil. The loss consists mostly of surface soil.

Gully erosion - This occurs when rills flow together into larger streams. These larger streams cut channels that ordinary tillage does not remove.

Bank erosion - As the name suggests, this refers to the cutting of banks by streams and rivers. It is very serious in time of floods because it destroys land, buildings, roads, and other valuable property.

Control of Water Erosion

Plant cover is a highly effective means of reducing the impact of raindrops. Dense growth will retain much water on the soil surface and only a limited flow will take place. Some vegetation, such as grass, tends to lodge under a heavy flow of water. This forms a thatch over which water flows without much opportunity for detaching soil. Plants tend to keep water spread uniformly over the land surface, helping to prevent rill and gully erosion.

Crop residues and mulches of hay, straw, and wood chips have proven to be an excellent substitute for plant cover in cultivated fields.

Additional aids within the cultivated area are plowing, which will destroy rills; contour plowing, which will create a series of small dams across a field; and terracing. Gullies should be filled where possible and stabilized with permanent vegetation. Trees and grasses should be established in large gullies. Bank erosion may be controlled with rock or brush bulkheads or willows.

Wind Erosion

Bouncing of soil particles by wind causes all types of wind erosion, and by controlling it, free flight and surface creep will also be controlled. There are three important ways to control bouncing soil particles in the cultivated field.

The first control involves using plants or trash on the soil surface.

The second method is accomplished by plowing and forming soil into clods or aggregates too large to be readily moved by wind.

A third method is by ridging the soil surface to trap bouncing particles. Measures outside the cultivated area, such as windbreaks and strip cropping, are also effective.

Fertilization

In order to improve soil fertility, an inventory must be taken of the soil's chemical and physical condition. The crop to be grown and amount of rainfall in the area are points to consider in the soil inventory as well as depth, permeability, slope, and drainage. A laboratory test is necessary to determine the nutrient deficiencies which may limit plant growth. The sense of sight is aided by the use of a shovel in determining conditions such as depth, droughtiness, slope, and other similar conditions.

Some soils need lime. This will be determined after a chemical test is made. The lime supplies calcium which is necessary for the proper growth of plants. Limestone is used to neutralize soil acidity, and it creates a favorable condition for plant growth. Its use also increases the benefits obtained from fertilizer and particularly those containing phosphorus. Liming an acid soil increases the growth and activity of the microorganisms which decompose soil organic matter.

Organic matter is necessary in the soil to maintain a desirable structure favorable to water infiltration and root development. Food and energy are provided for the soil microorganisms and enable them to perform their many useful services in decomposing residues and making nutrients available for nourishing plant growth.

Organic matter is also an important source of plant nutrients. It contains a certain amount of nitrogen and phosphorus that helps supply plant food in the surface soil.

Continued cultivation has reduced organic matter content in many of the soils to the point where lack of nitrogen and phosphorus limit plant growth.

In many cases organic matter losses in cultivated soils vary from 25 to 50 percent. Organic matter and nitrogen accumulate most rapidly in undisturbed soils planted to deep rooted, sod-forming crops such as alfalfa, sweet clover, and grass-clover mixtures.

It is difficult to know exactly how much fertilizer would have to be applied to obtain the best possible yield of any particular crop. The farmer's consideration in buying fertilizer is maximum profit and not maximum yield. There is a point beyond which fertilization will not improve crop yields enough to pay the cost of the extra fertilization. Fertilizer should be applied correctly and at the time when it will be most valuable to growing crops.

Crop Rotation Values

Transparency No. 6

The individual farmer must determine the system of crop rotation and management to use. Rotation serves to maintain crop yields; conserve soil and water; improve tilth; maintain organic matter; permit more profitable use of fertilizer, lime, and manure; keep the soil occupied; change the feeding range; counteract toxic substances; and improve crop quality.

Nitrogen is much cheaper than it was several years ago. Farmers or ranchers must decide if they can buy nitrogen and apply it on cropland more economically rather than trying to grow legumes for nitrogen fixation. On the other hand, by growing cover crops the land can be protected and at the same time provide an abundance of good pasture. The cover is a source of organic matter which improves fertility.

Many factors determine the crop rotation methods used. Erosion hazards may be too great to permit successful rotation.

Cultivation

The main objectives of cultivation are to control grasses and weeds for soil aeration and to conserve soil moisture. Proper cultivation makes soil more receptive to rain water and helps eliminate erosion. However, many farmers have a tendency to cultivate too often. Losses of water, soils, and nutrients are at their highest peaks during periods of cultivation. Energy can be saved by reducing the amount of plowing, cultivation, and seedbed preparation; cultivation must be adequate but not overdone if it is to be economical.

Cultivation should be deep enough to control weeds but not too deep, or it will cut off a lot of plant roots. Shallow cultivation is best for most crops. Plow only as necessary to control weeds and to keep the soil ready for absorbing as much rain water as possible. With chemicals now being used for weed control, the practice of reduced or minimum tillage is being recommended everywhere.

The timely plowing under of crop residue is an effective means of controlling certain insects. In many instances, quarantines require early destruction of crop residues to help destroy crop insects.

Other Management Practices

Land use makes a considerable difference in controlling erosion. Shallow, sloping soils with low fertility levels are limited in their capabilities and require careful management. In such cases, the land should be taken out of cultivation and placed in close growing crops and pasture. The dense grass cover of pastures breaks the impact of pounding raindrops on the surface, slows runoff, and reduces erosion.

Burning residue on pasture and croplands promotes accelerated erosion. In actual tests, water runoff on sloping land where the vegetation cover was destroyed by burning was 30 times greater than on protected land. In the same tests, soil losses were 14 times greater on land where the vegetative cover had been burned. Burning crop residue on meadows has reduced hay yields as much as 60 percent. This is due to loss of water and destruction of the mulch cover on the land. Burning of crop residues on cultivated land destroys one of the principal sources of organic matter and hastens the depletion of soil fertility.

3. Conclusion

The very backbone of our agricultural industry depends upon our high important resource--soil. The land has been the source of our strength in time of war. It is a basis of our security and economic stability in time of peace.

With a fast growing population and a rapidly expanding economy, there are terrific demands upon our land. We continually have the job of building our depleted soils and adequately conserving them for both present and future needs.

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GLOSSARY OF TERMS

Accelerated erosion - erosion more rapid than natural, normal, or geologic erosion. Accelerated erosion results from the activities of humans and animals or of a catastrophe in nature that exposes the surface of soil to erosion causing agents.

Free flight - a form of wind erosion in which the soil particles are small enough to be carried long distances.

Gully - a miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. A gully is an obstacle to farm machinery and is too deep for ordinary tillage practices.

Hectare - a universal unit of land area measure. One hectare equals 2.47 acres.

Lodge - to fall or lie down.

Mulch tillage - tillage of the soil and treatment of crop residues in ways to leave plant materials within or on the soil surface to form a mulch.

Plowpan - a compacted layer formed in the soil directly below the plowed layer.

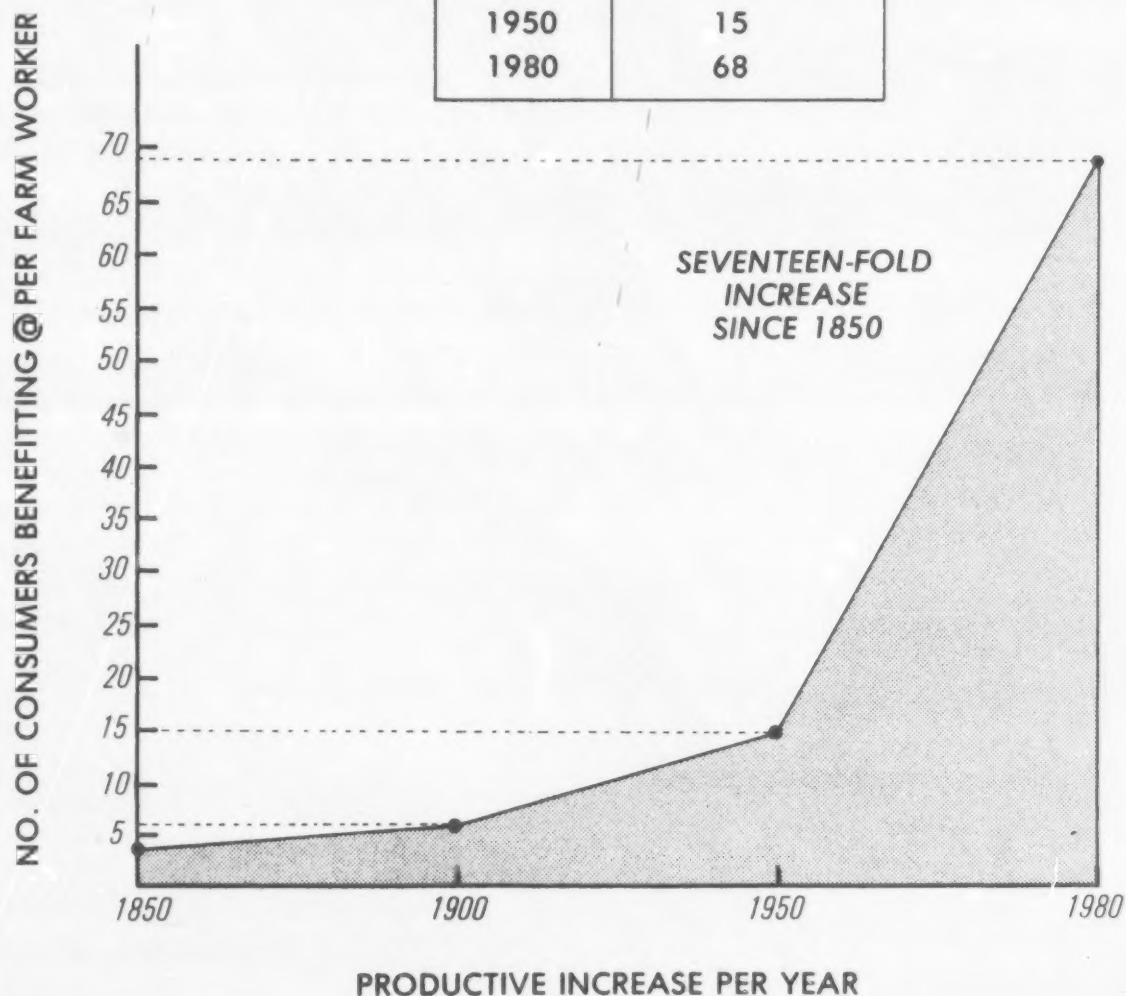
Rill - a steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Surface creep - a type of soil movement caused by the wind. Soil particles too large to be rolled are moved downwind by constant bombardment from smaller bouncing particles.

INDIVIDUAL FARM WORKER PRODUCTIVITY

OUTPUT PER UNIT OF INPUT
(NO. OF CONSUMERS) (FARM WORKER)

Year	Consumers
1850	4
1900	6
1950	15
1980	68



MEETING THE OBJECTIVES OF TILLAGE

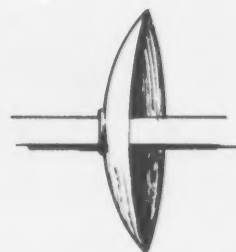
TEMPORARY SOIL CONDITIONING

SEEDBED PREPARATION

ADEQUATE MOISTURE

SATISFACTORY TEMPERATURE

CERTAIN AMOUNT OF OXYGEN



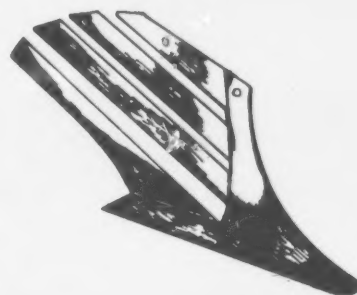
PLANTING DEPTH

CULTIVATING ROW CROPS

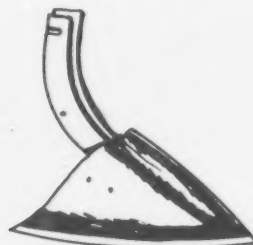
WATER INTAKE

AIR MOVEMENT

WEED CONTROL



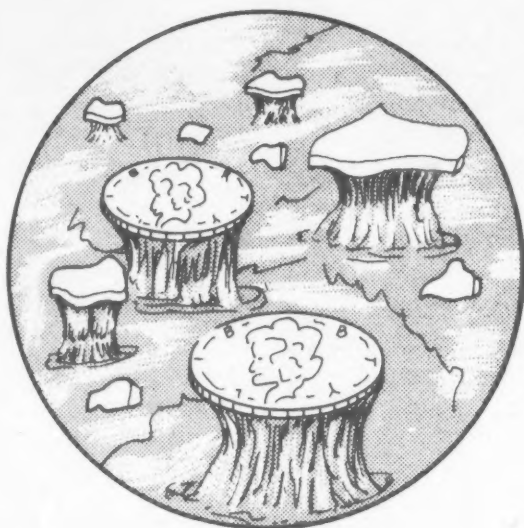
HANDLING CROP RESIDUES



TILLAGE EQUIPMENT

1. MOLDBOARD PLOWS
2. DISK HARROWS
3. DISK TILLERS OR ONE-WAYS
4. ROTARY TILLERS
5. SPRING-TOOTH HARROWS
6. SPIKE-TOOTH HARROWS
7. CULTIPACKERS
8. ROD WEEDERS
9. BLADE OR SHOVEL TILLERS
10. SUBSURFACE TILLERS

SOIL DETACHMENT BY RAINDROPS



A GRAPHIC ILLUSTRATION
OF EROSION BY RAIN

SOIL PARTICLES
AND GLOBULES OF
MUD ARE HURLED IN
ALL DIRECTIONS WHEN
A WATER DROP STRIKES
WET SOIL.



COMMON TYPES OF WATER EROSION RESULTING IN SOIL DEPOSITION



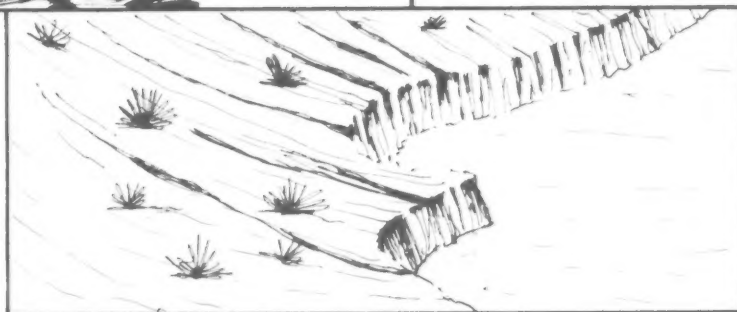
SHEET EROSION

RILL EROSION



GULLY EROSION

BANK EROSION



CROP ROTATION VALUES

1. MAINTAIN CROP YIELDS
2. CONSERVE SOIL AND WATER
3. IMPROVE SOIL TILTH
4. MAINTAIN ORGANIC MATTER
5. PERMIT MORE PROFITABLE USE OF FERTILIZERS,
LIME, AND MANURE
6. KEEP THE SOIL OCCUPIED
7. CHANGE THE FEEDING RANGE
8. COUNTERACT TOXIC SUBSTANCES
9. IMPROVE CROP QUALITY

SOIL SCIENCE

Unit B: Managing Soils

Topic 4: Managing Grassland Soils

Suggested Procedures and Activities: (1) Published soil surveys contain pastureland management information which can be used to supplement the information in this topic. (2) A series of publications entitled Pasture Management Guidelines and slides to accompany the series are available from the Vocational Instructional Services Center and can also be used to supplement the information in this topic.

Note: All terms underlined are included in the "Glossary of Terms" at the end of this topic.

1. Introduction

Growing grasses and legumes for pasture and hay is a very effective means of conserving soil and water. Research has revealed great differences in measured losses of soil and water from land in grass and from land in cultivated crops. The studies showed that only about 12% of the rain falling on sod was lost, but more than 27% of the rain falling on cultivated cornland was lost. In addition, soil loss on the cultivated cornland was very severe, and it was estimated to take only 56 years to erode seven inches of topsoil when the land was in corn continuously. With the land in permanent sod, it would take more than 3,500 years to erode the seven inches of topsoil.

One of the important ways in which close vegetation protects the ground surface is through the interception of rainfall by leaves. Research has shown that as much as one-half inch of rain is retained upon the leaves and stems of a good stand of alfalfa. Another important water-conserving effect of close vegetation is it keeps surface water clear by protecting the soil from the beating action of rain. Soil absorbs clear water at a much higher rate than muddy water.

Another effect of growing grasses and legumes is the maintenance in the soil of a high content of humus and organic matter. Cultivation destroys organic matter rapidly. Grasses and legumes, whether in permanent pastures or in a good crop rotation, tend to maintain a normal or high content of organic matter. Soils high in organic matter may have a water penetration rate more than double those soils without any organic matter. A soil with a high water penetration rate loses very little water and soil due to runoff.

2. Establishing a Grassland Soil Management Program

In grassland management, the soil should be considered first just as it should in all other phases of farm management. The soil is the foundation of all good farming. Poor soils usually mean poor quality grasses and legumes. Poor quality grasses and legumes mean poor livestock. Properly managed soils produce nutritious forage and healthy livestock.

Transparency No. 1

Good soil management for pasture includes proper choice of plants, fertilization, maintenance of a favorable soil reaction, timely and rotation grazing, weed and brush control, and an adequate water supply.

Transparency No. 2

Soils for hay production require the same management procedures as required for pasture. However, instead of a timely grazing program, hay requires timely harvesting at the correct stage of growth.

Proper Plant Selection

Land used for pasture and hay generally is planted to introduced grasses and legumes which respond to good management.

Transparencies No. 3, No. 4, No. 5, and No. 6

Improved pasture plants vary in many characteristics, but there is no "miracle plant." Many plants are available which, if properly managed, will provide the desired production of forage. Consider plants adapted to fit the particular soil, climate, and livestock situation. Choose plants which when properly managed will likely provide the desired quality and the greatest amount of forage needed.

A legume-grass combination should be used for pasture whenever possible to increase quality, animal performance, period of grazing, and decrease investment in fertilizers. Legumes provide part of the nitrogen requirement of the grass. Legume-grass forage is higher in quality than grass alone and provides a longer period of grazing. A cool-season annual grass such as rescue or rye-grass can be added to legume pasture to reduce the bloat hazard of legumes.

Fertilization

Fertilization is necessary and profitable because it increases yields, protein and mineral content of forage, efficiency of water use, and aids in weed control. After supplying fertilizer needs for establishment, provision should be made for a continuing adequate supply of plant food for the growing plants. Nutrients removed in grazing, hay, or silage must be replaced to maintain yields. Plants growing in a pasture have a higher fertility requirement than most row crops.

A certain minimum fertility level is necessary just to keep pasture plants vigorous so they will compete with weeds. Additional fertilizer should be used to obtain forage desired, with consideration given to moisture, plant response, and method of utilization.

Intensification of pasture production and stocking rates are a must in order for fertilization to be profitable. More profit is realized by adequately fertilizing a few acres than by spreading a little fertilizer over many acres. Many things are taken into consideration when making soil test fertilizer recommendations. Among these are type of pasture plants, present fertility level of the soil, expected moisture, and method of forage utilization--grazing or hay, or a combination of both.

Obtain a soil test for the best indication of fertilizer needs, based on expected plant response and method of forage utilization. It is important to submit adequate and complete information on the information sheet which is to accompany a pasture soil sample for testing.

Transparency No. 7

The total annual requirement of nitrogen for grasses should be applied in three to four applications to maintain production and quality.

Phosphorus can usually be applied in one yearly application and consideration should be given to high initial rates of phosphorus at the beginning of the pasture improvement program to immediately raise the soil phosphorus to a medium-to-high level. Phosphorus applications in subsequent years can be possibly reduced, but a medium-to-high level of phosphorus should always be maintained in the soil.

Potassium (potash) should be adequately supplied to meet the plants' needs on an annual basis. The annual requirement may be split into two applications (1/2 in early spring, and 1/2 after second hay cutting or grazing), if less than two hundred pounds are applied annually. If over 200 pounds is applied it can be done in one application. Leaching would be more likely on sandy soils.

In a grass pasture, where a legume is not present, an initial balanced fertilizer should be applied immediately prior to or at the time the grass begins growth. The total phosphorus needs can be supplied in the first application and additional nitrogen and potash would be added when needed later in the season.

Although some forms of fertilizer such as urea are most efficient when applied in the soil, most forms can be applied satisfactorily as a top dressing on established pasture sods. Any advantage to applying these in the soil does not offset the extra cost and damage to established plants. Phosphate and lime should be applied before the time needed as they move very slowly down into the soils.

Research has shown that the renovation of dense grass sods such as bermuda solely for the purpose of stimulating grass growth may not be beneficial. It will usually be more profitable to spend the same amount of money on fertilizer applied on the surface of the sod. Some renovation is necessary where legumes or a different grass are to be established in a sod.

Legume-grass pastures require a different fertilizer program from those where grasses only are grown. Cool-season legumes must have an adequate supply of phosphorus and potash and a suitable pH when growth starts in the fall. Some nitrogen is usually needed when legumes are first being established and during subsequent early season growth. Productive legumes such as properly fertilized white clover will furnish a large portion of nitrogen needed by the grasses. If hay cuttings are desired, additional nitrogen should be applied in late spring and summer.

If less productive legumes are being used or if there is poor legume growth, additional fertilizer (principally nitrogen) will be needed for the grass. Some research has indicated that as much as 100 pounds of nitrogen may be applied to grasses without reducing legume stands. Late spring and early summer is when nitrogen is usually applied to grasses. Late summer nitrogen applications may stimulate the grass to such an extent that it could crowd out the legume. Close grazing or clipping could offset this.

Maintenance of Proper pH Level

Lime is necessary to supply calcium in soils that are deficient, and to correct soil acidity. The more productive legumes require a higher pH than grasses. Aim for a pH of 7 in your soils. Apply lime one year before needed to keep pH high.

Grazing Management

From the standpoint of forage production, the grazing management program (stocking rate) should be such as to avoid continuous defoliation; that is, it should permit adequate periods for grass recovery. Plants vary in their ability to remain vigorous under conditions of close grazing. Sod-forming grasses such as bermuda, dallis, and bahia can withstand closer grazing than upright bunchtype grasses such as blue panic and buffel.

Since the forage produced is to be marketed through livestock, major considerations must be given to managing the grazing program to provide the quantity and quality of forage for best animal performance. In many instances, this will represent a compromise between what is best for the plant and what is best for the animal. Excessive growth of mature forage is unpalatable and low in food value and is worth little for grazing or as hay or silage. A pasture, therefore,

could be underused to the extent that although much surplus forage is visible, it may be so low in quality due to over-maturity that animal performance could be as poor or worse than under conditions of over-use where insufficient quantity of forage is the problem. Pasture plants should be clipped, if maturing too rapidly (14 to 45 days depending upon system of grazing), to allow plants to make a regrowth of higher quality forage.

The optimum stocking rate for a given pasture will vary according to the type, quantity, and quality of forage available. It is established by giving consideration to plant response to fertilizer and moisture, individual animal nutritional needs and performance, and production per acre. Under optimum stocking in a continuously grazed pasture, some visible surplus forage will be evident at all times. If no surplus is evident, then the pasture is overstocked and some or all of the animals should be removed to allow plant recovery. One rule of thumb is to allow plants to grow to a height of four inches average; however, do not let forage develop high spots of mature grass without shredding back to the four inches. Under optimum stocking, in both continuous and rotational grazing systems, there should be some excess surplus forage accumulate during certain periods of the year to be utilized as hay, silage, or haylage. Stock rate goals should be aimed at providing sufficient forage to graze animals and to cut hay for wintering cattle.

Transparency No. 8

A system of rotational grazing--dividing pasture into several blocks-- can be beneficial, especially in high-producing pastures. In this system, livestock are rotated from block to block as needed. This rotation is followed by shredding all mature forage to bring it back to a vegetative growth of quality. This system requires more careful management than continuous grazing, but it is easier to maintain quality in forage with rotation. Care must be taken to remove animals from a block before the amount of forage becomes deficient to the extent that animal performance is adversely affected. When animals are rotated to a new block, the forage growth should be such as not to be overly mature. If grass is maturing too fast, cut it for hay.

Rotational grazing allows for better use of excess forage as hay or silage and less loss by trampling and soiling. It also provides for better management in regard to fertilization and irrigation.

In pastures where legumes are to be established in the fall or legume reseeding is desired, the grass should be grazed short or clipped for hay to allow sunlight to reach the soil when the legumes begin to germinate and grow. Dry forage should be offered to cattle grazing very young and succulent growth to provide body requirements for dry matter.

Weed and Brush Control

Weeds and brush are usually a minor problem in good stands of adapted grasses which are fertilized as needed and properly grazed. Chemical or mechanical weed and brush control is not a substitute for proper fertilization and management. Weeds and brush may use one-third or more of the fertilizers applied if not controlled. Chemical control of brush and most broad-leaved weeds can be effectively obtained with the proper use of 2, 4-D herbicides and is more effective and economical than mechanical control.

Irrigating Pastures

Applying irrigation water to pastures can be profitable in many instances but not always. The following points should be considered:

- a. Use only well-adapted plants with good potential for high quality and high production.
- b. Temporary pastures give quickest returns and usually the highest quality forage. Normally they also give the best animal performance per day of grazing.
- c. Use proper grade and amount of fertilizer at the right time.
- d. Good grazing management is necessary.
- e. Livestock should be of good quality and mature enough (450 to 550 lb.) to utilize forages.
- f. Dairy cattle are most likely to make pasture irrigation pay. However, it can be profitable with other livestock as well by making possible an increase in hay production. Irrigated pastures can often be profitably used to supplement native ranges and dryland pastures and provide insurance against dry weather hazards. Better management of native ranges and dryland pastures is made possible by irrigating pastures.
- g. Water will not substitute for fertilizer, but it will cause greater fertilizer efficiency.

3. Summary

It must be remembered that any growth on the soil affords better protection from erosion than no growth. However, the finer the growth and the longer it grows during the year, the better it protects the soil. For this reason, the growing of grasses and legumes for pasture and hay should be the rule rather than the exception on many farms and ranches.

A good soil management program will also yield higher net returns to the farmer and rancher. Improved soil and high yields of grasses and legumes will result from a well-managed program of plant selection, fertilization, liming, grazing, harvesting, weed and brush control, and irrigation.

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GLOSSARY OF TERMS

Optimum stocking rate - the stocking rate at which conditions will be most favorable for continued growth and grazing of forage.

Permanent pasture - pasture covering the soil for a long period of time in contrast to rotation pasture covering the soil for only one or two years in a rotation cycle with other crops.

Renovation - restoration to life, vigor, or a former state.

Sod - the grass and forb covered surface of the soil.

Temporary pasture - pasture covering the soil for a short period of time and usually used in rotation with field crops.

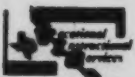
SOIL MANAGEMENT PROGRAM

(PASTURE)

- ★ PROPER PLANT SELECTION
- ★ FERTILIZATION
- ★ PROPER pH LEVEL
- ★ TIMELY GRAZING
- ★ ROTATION GRAZING
- ★ WEED AND BRUSH CONTROL
- ★ ADEQUATE MOISTURE

SOIL MANAGEMENT PROGRAM (HAY)

- ★ PROPER PLANT SELECTION
- ★ FERTILIZATION
- ★ PROPER pH LEVEL
- ★ HARVESTING FORAGE AT CORRECT
STAGE OF GROWTH
- ★ WEED AND BRUSH CONTROL
- ★ ADEQUATE MOISTURE



GRASSES FOR IMPROVED PERMANENT PASTURES



- | | | |
|------------------------|-----------------------------|-------------------------|
| 1. Bahia | 14. Pretoria 90 | 27. Napier |
| 2. African Star | 15. Blue panic | 28. Orchard |
| 3. Coastal | 16. Brome, smooth | 29. Rescue |
| 4. Coastcross-1 | 17. Buffel | 30. Rhodes |
| 5. Common bermuda | 18. Columbus | 31. Ryegrass, annual |
| 6. Giant bermuda | 19. Dallis | 32. Ryegrass, perennial |
| 7. Midland | 20. Desoto | 33. Sorghum alnum |
| 8. Angleton | 21. Fescue-Ky. 31, Alta 144 | 34. Switch |
| 9. Australian | 22. Guinea | |
| 10. Caucasian bluestem | 23. Indian | |
| 11. Gordo | 24. Johnson | |
| 12. K. R. bluestem | 25. Kleingrass | |
| 13. Medic | 26. Lovegrasses | |

LEGUMES FOR IMPROVED PERMANENT PASTURES



- | | | |
|-----------------|---------------------|--|
| 1. Alfalfa | 8. Hop | 15. Lespedeza, Sericea |
| 2. Alyce clover | 9. Persian abon. | 16. Singletary Peas |
| 3. Black medic | 10. Persian common | 17. Hubam |
| 4. Burclover | 11. Red | 18. Floranna |
| 5. Ball | 12. White | 19. Israel |
| 6. Berseem | 13. Cowpeas | 20. Madrid |
| 7. Crimson | 14. Lespedeza, Kobe | 21. Sweetclover - common biennial yellow |
| | | 22. Vetch |

SUMMER TEMPORARY PASTURE PLANTS



- | | |
|-------------------------------|---|
| 1. Alyce clover | 8. Rescue grass - Lamont, Chapel Hill, and Texas 46 |
| 2. Barley | 9. Rye - Elbon, Gator |
| 3. Cowpeas | 10. Ryegrass - Annual, Common, and Gulf |
| 4. Legumes | 11. Sorghum alnum, Columbus, and Desoto grasses |
| 5. Millet - Browntop, Foxtail | 12. Sorgrass |
| 6. Oats | 13. Sudan varieties and hybrids |
| 7. Rape | 14. Wheat |

WINTER TEMPORARY PASTURE PLANTS



1. RYEGRASS, ANNUAL

- a. Common
- b. Gulf

2. RESCUEGRASS

- a. Lamont
- b. Chapel Hill
- c. Texas 46

3. SMALL GRAINS

- a. Rye
- b. Wheat
- c. Oats
- d. Barley

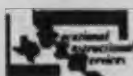
4. LEGUMES (cool season)

- a. Black Medick
- b. Burclover
- c. Ball Clover
- d. Berseem Clover
- e. Crimson Clover
- f. Hop Clover
- g. Persian Clover
- h. Red Clover

- i. White Clover
- j. Madrid Clover
- k. Vetch
- l. Singletary Peas
- m. Hubam Clover
- n. Floranna Clover
- o. Israel Clover
- p. Arrowleaf Clover

EXAMPLE OF A RECOMMENDED FERTILIZER APPLICATION

QUANTITY	TYPE OF FERTILIZER	TIME OF APPLICATION
300 lbs.	0-20-20	February
80 lbs.	Nitrogen (topdressed)	Late April or early May
100 lbs.	Nitrogen (topdressed)	After first hay cutting or grazing
100 lbs.	Nitrogen	After second hay cutting or grazing
60 lbs.	Potash	
100 lbs.	Nitrogen	After third hay cutting or grazing



EXAMPLES OF TWO DEFERRED - ROTATION GRAZING SYSTEMS

I. SWITCHBACK - 2 PASTURES - 1 HERD

		PASTURE G	PASTURE H
1st. year:	March 13 to June 15	Graze	<u>Rest</u>
	June 16 to Dec. 15	<u>Rest</u>	Graze
	Dec. 16 to March 15	Graze	<u>Rest</u>
2nd. year:	March 16 to June 15	<u>Rest</u>	Graze
	June 16 to Dec. 15	Graze	<u>Rest</u>
	Dec. 16 to March 15	<u>Rest</u>	Graze
3rd. year:	March 16 to June 15 etc.	Graze	<u>Rest</u>

II. 4 PASTURES DEFERRED - ROTATION SYSTEM - 3 HERDS

	PASTURE	K	L	M	N
1st. year:	Feb. 16 to June 15	Graze	Graze	Graze	<u>Rest</u>
	June 16 to Oct. 15	<u>Rest</u>	Graze	Graze	Graze
	Oct. 16 to Feb. 15	Graze	<u>Rest</u>	Graze	Graze
2nd. year:	Feb. 16 to June 15	Graze	Graze	<u>Rest</u>	Graze
	June 16 to Oct. 15	Graze	Graze	Graze	<u>Rest</u>
	Oct. 16 to Feb. 15	<u>Rest</u>	Graze	Graze	Graze
3rd. year:	Feb. 16 to June 15 etc.	Graze	<u>Rest</u>	Graze	Graze

SOIL SCIENCE

Unit C: Agencies Assisting in Soil and Water Conservation

Topic 1: Soil Conservation Service

Suggested Procedures and Activities: (1) Plan a field trip to a farm following a conservation plan developed by the Soil Conservation Service. (2) Invite a Soil Conservation Service representative to visit the class to explain the operation of the Service. (3) Provide students with aerial photographs of local farms practicing soil conservation.

1. Introduction

Americans are becoming increasingly concerned about conservation of natural resources. Soil is one of America's most prized natural resources and has been the object of concern for many years. It is true that over a century ago many of the farmers tilled the soil until it no longer produced satisfactory results. They showed little concern for its care and protection because virgin land was available. Consequently, new land became scarce, and farmers and ranchers became concerned about conserving the soil and other natural resources. Some of the farmers of the new America recognized the need for improved farm practices and contributed to soil protection by farming on the contour and by ditching and terracing. Presidents Washington and Jefferson encouraged and practiced conservation. The creation of national forests and national parks helped promote conservation. Finally, in 1935, the Soil Conservation Service was established and quickly became the leader in the promotion and development of conservation practices.

2. Purpose of the Soil Conservation Service

The Soil Conservation Service, as its name indicates, has the conservation of soil and water as its primary purpose. It strives to keep the constructive and destructive processes of nature in balance. The SCS is involved in developing a spirit of cooperation between the farmers and the general public in maintaining the land, water, wildlife, and forests of this country. The Service is involved in a program of education assisting farmers and ranchers in land management to increase yields, to reduce energy requirements, and to improve efficiency. The SCS also assists in planning recreational facilities for land-owners.

Transparency No. 1

Vocational agriculture students should have an understanding of the operation of the Soil Conservation Service because most agricultural enterprises may be

involved in some way with the SCS. As a part of the United States Department of Agriculture, the SCS is organized into State Soil Conservation Service Commissions which in turn establish local conservation districts. There is usually one relatively self governing SCS office in each district. The local farm planning staff may be assisted by one or more specialists and other staff members from higher organizational levels. When a farmer or rancher requests assistance, the local farm planner coordinates and pools the knowledge of the entire Service to develop the best possible progressive farm management plan.

3. Functions of the Soil Conservation Service

Farm and ranch planning are the major functions of the SCS. The 3,000 plus conservation districts, covering more than one billion acres of land, provide daily assistance to farmers and ranchers. It is estimated that assistance has been provided for more than 4.5 million farmers and ranchers in the 50 states, Puerto Rico, and the Virgin Islands. About 99% of the farms in the United States are a part of some conservation district. As a result of these efforts for conservation, it is estimated that over one million farmers have applied some form of crop rotation system over one-half billion acres of land. Cover crops have been planted on over 20 million acres, strip cropping on another 20 million acres, and grass has been seeded or sodded on about 30 million acres of pasture land. In addition, millions of acres of rangeland have been cleared of brush or have had other principles of good range management applied.

A. Drainage and Erosion Control

Transparency No. 2

Drainage and erosion control is of primary interest to the Soil Conservation Service. In 1920 about 65 million acres of land were under some type of drainage control program. Today this has increased over 50% to 100 million acres with most of the increase being located in Texas, Louisiana, and Florida. The major portion of artificial drainage control in the United States is along the Gulf Coast and the Ohio and Mississippi River Valleys.

The need for drainage districts is greatest where the water table is high or the surface rate of water absorption is slow. These areas are drained by either surface ditches or by underground tile drains.

Various techniques were employed in an attempt to control unwanted movement of the soil. Terracing became one of the most common methods; over one million miles of terraces aided in protecting about 25 million acres of land.

Transparency No. 3

SCS helped farmers in the "Dust Bowl" region establish wind breaks to cut down wind erosion. Thousands of acres of cover crops were planted. An educational program on crop residue management and sub-surface tillage was implemented.

B. Irrigation

Transparency No. 4

Water, being the most important factor limiting the progress of our nation, is of great concern to the Soil Conservation Service. Across the nation, irrigation has increased productivity about 50%. The Mormons began irrigating their land around 1847. Since that time the number of irrigated acres has increased to 40 million. Although irrigation is most concentrated in the southern and western states, it promises to spread to other areas. Even humid areas receiving as much as 40 inches of rainfall may have 50- to 60-day periods of drought. The arid and semi-arid regions of the west are productive when irrigated; in the high plains of Texas, production has been increased by as much as 200% with irrigation. Research has indicated that in some western states irrigated pastures are the most profitable enterprise.

C. Wildlife and Farm Ponds

The Soil Conservation Service provides assistance in developing management practices that will be helpful to the wildlife in the area and increase the recreation value of the farm.

General recommendations stress the importance of maintaining fence rows and hedges as cover for wildlife. In developing farm plans, an effort is made to utilize waste lands and marshes for wildlife and encourage proper management of farm ponds.

Conservation programs cut down sediment movement and help keep streams clear. Reforestation, range management, and many other practices help provide food and cover for game.

Measures helpful to wildlife are planned with Soil Conservation Service assistance on almost every soil and water conservation district cooperator's land.

Ponds, lakes, and watershed dams provide hundreds of additional fishing sites and resting and feeding places for waterfowl.

Many soil and water conservation district cooperators are installing fish-for-pay or hunt-for-pay enterprises on their farms and ranches. The SCS gives technical assistance on these enterprises.

D. Urban Development Programs

Transparency No. 5

The Soil Conservation Service initiates and conducts soil and water conservation programs to help city dwellers and businesses.

E. Rural Areas Development

Development of rural areas is the main goal of all programs administered by the SCS. Programs range in size from conservation plans for single farms or ranches to plans for entire watersheds or resource conservation and development projects under Public Law 566 and related acts.

The soil, water, range, and forest resources of the United States are the foundation blocks in the structure of our national economy. From that base comes our food; the bulk of our agricultural, municipal, and industrial water supplies; most of our clothing, paper, and other fibers; much of our shelter; and a large part of the public's opportunities for outdoor recreation.

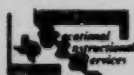
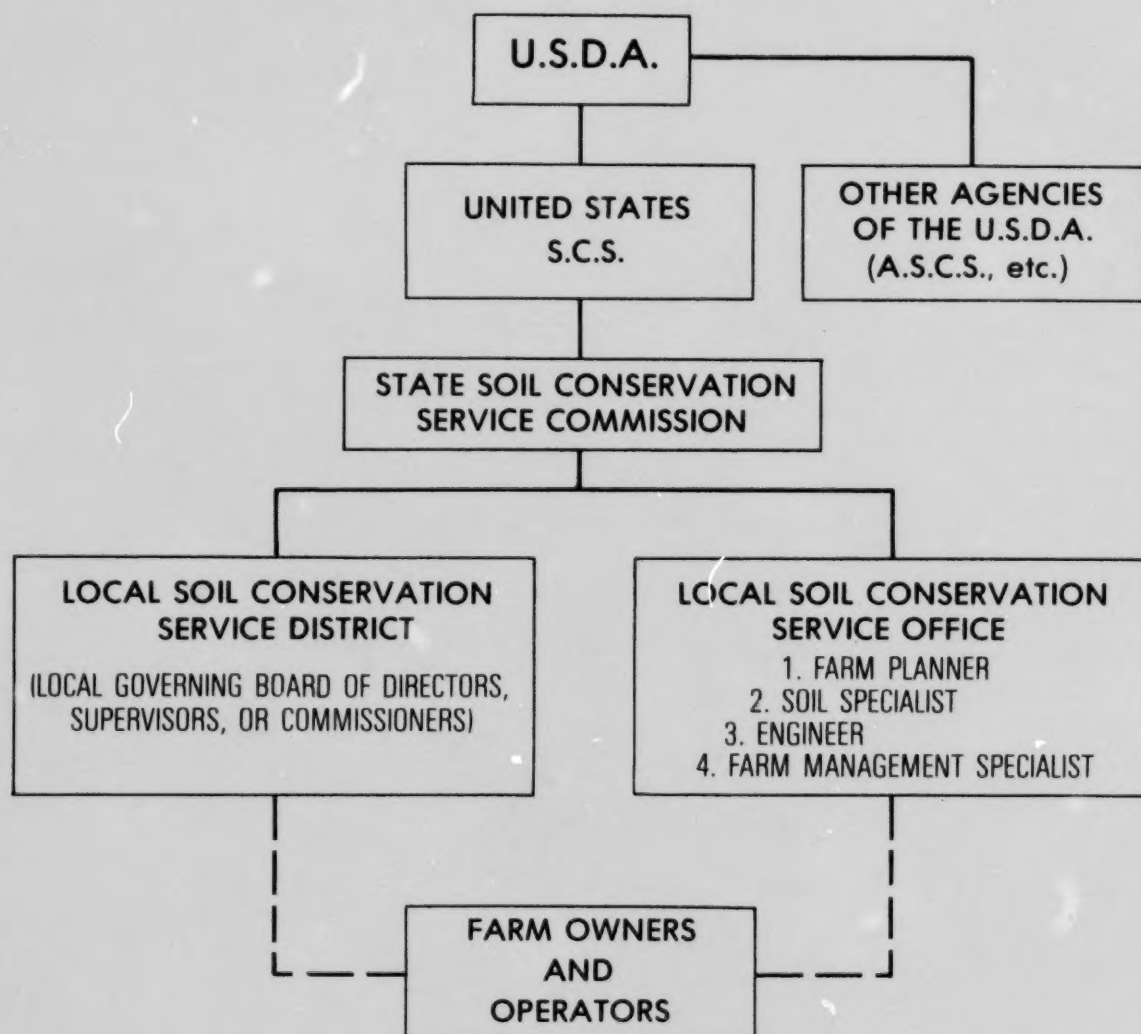
How well we protect and improve these resources has a direct and immediate bearing on the incomes and standard of living of the people who live on farms and ranches. Their prosperity and the soil and water conservation work they perform are in turn reflected by the well-being of all Americans.

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ORGANIZATIONAL STRUCTURE OF THE SOIL CONSERVATION SERVICE



AGRICULTURAL LAND IN ARTIFICIAL DRAINAGE



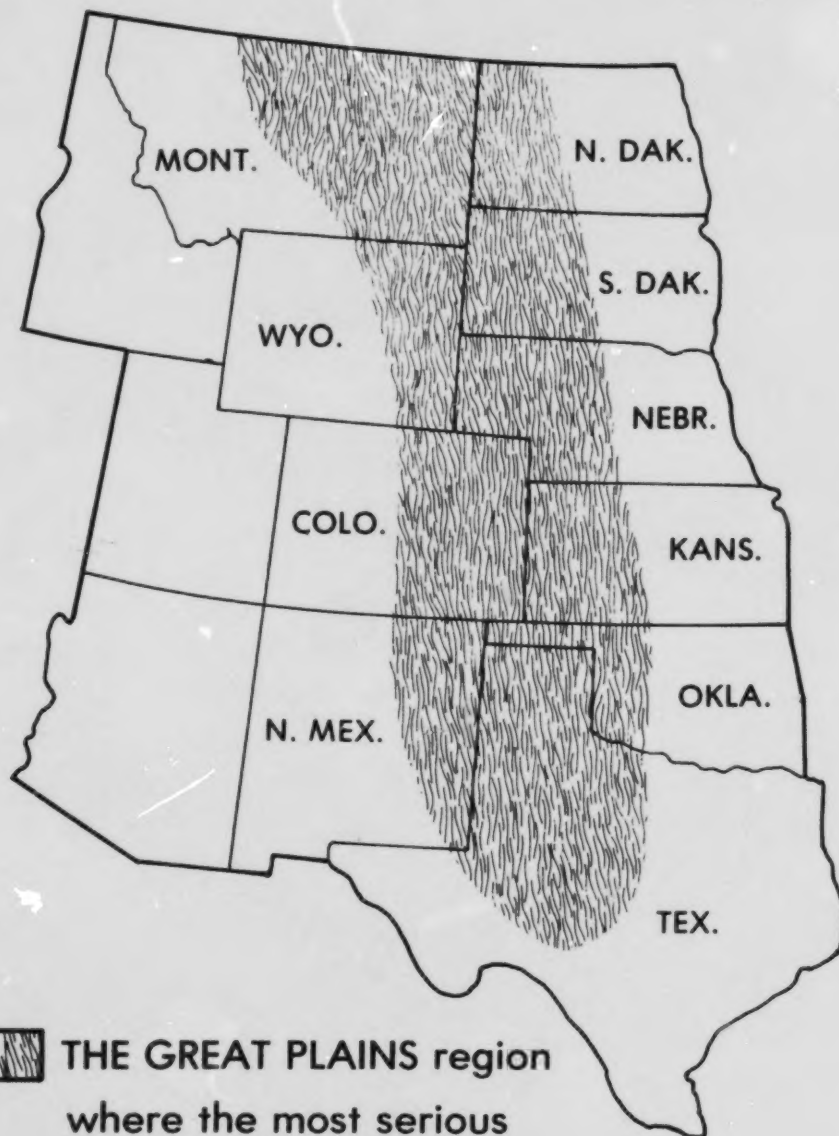
UNITED STATES NET TOTAL

100 MILLION ACRES
(40.5 MILLION HECTARES)

1 DOT=10,000 ACRES
(4,050 HECTARES)

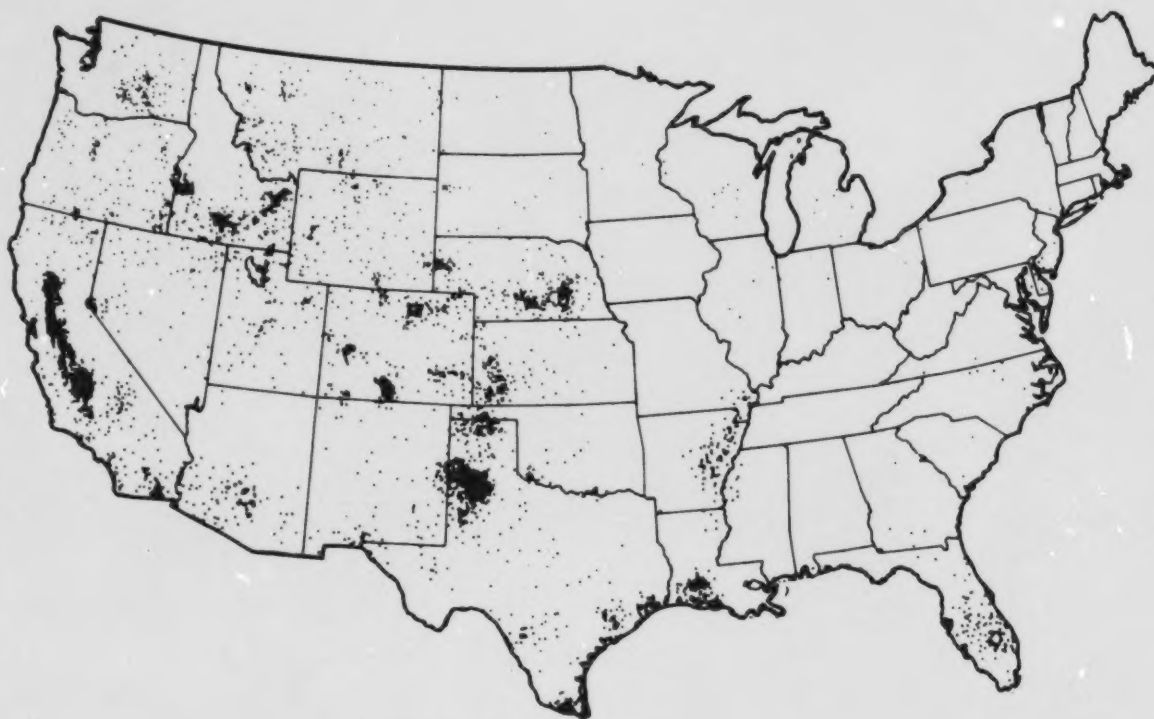
(COUNTY UNIT BASIS)

GREAT PLAINS WIND EROSION AREA



THE GREAT PLAINS region
where the most serious
wind erosion takes place.

IRRIGATED LAND IN THE UNITED STATES



UNITED STATES TOTAL

40 MILLION ACRES
(16.2 MILLION HECTARES)

1 DOT=10,000 ACRES
(4,050 HECTARES)

URBAN DEVELOPMENT PROGRAMS

1. THE SOIL CONSERVATION SERVICE CAN GIVE DIRECT ASSISTANCE IN SELECTING:
 - a. *building sites*
 - b. *septic tank locations*
 - c. *measures to prevent erosion*
 - d. *solutions to other soil and water related problems*
2. CONSERVATION PROGRAMS:
 - a. *improve trade area income*
 - b. *stimulate bank deposits*
 - c. *promote sale of consumer goods*
 - d. *create a more stable tax base*
3. CONTRACTORS WHO INSTALL CONSERVATION PRACTICES:
 - a. *provide jobs*
 - b. *create markets for machinery, petroleum products, and other materials*
4. SOME WATERSHED PROGRAMS CREATE MUNICIPAL WATER SUPPLIES WHICH:
 - a. *attract industry*
 - b. *create jobs*
 - c. *raise community income*

SOIL SCIENCE

Unit C: Agencies Assisting in Soil and Water Conservation

Topic 2: Agricultural Stabilization and Conservation Service

Suggested Procedures and Activities: (1) Plan a field trip to a farm participating in an ASCS program. (2) Invite an ASCS representative to visit the class to explain the operation of the Service.

Note: All terms underlined are included in the "Glossary of Terms" at the end of this topic.

1. Introduction

America's position, power, and wealth are a direct result of the productivity of the soil. Today's agriculture is faced with the task of producing food and fiber for an ever increasing number of Americans and millions of people in other countries. Maintaining our productivity depends largely on our wise management of the soil and its products. The Agricultural Stabilization and Conservation Service (ASCS) was created by the United States Department of Agriculture to assist in regulating crop production and to provide incentives for good conservation practices.

2. Principal Activities of the ASCS

Transparency No. 1

The ASCS is involved in a variety of activities. Price support is carried out by commodity loans and payments to farmers. These are made through direct purchases of agricultural products from farmers and processors. Production adjustments are accomplished through acreage allotments; diverted acreage; and payments for reducing production in several crops which include cotton, tobacco, rice, peanuts, wheat, corn, and other feed grains. There are incentive payments for some basic commodities to encourage production. Conservation and adjustment of land use are encouraged by the ASCS. Assistance is provided individual farmers in accomplishing needed improvements such as soil, water, woodland, and wildlife conservation. The Commodity Credit Corporation (CCC) is involved in the sales, storage, processing, and shipping of various commodities. Special assistance and priority are given to the school lunch programs, senior citizens, and armed forces. Disaster and emergency relief is provided for farmers who may have lost their supplies or products as a result of floods, droughts, or other natural disasters. Finally, the ASCS is involved in the administration of grain reserve program agreements involving wheat and feedgrains.

3. Programs of the ASCS

Transparency No. 2

A. Production Adjustment Program

Programs to help adjust production and marketing of specified farm crops, when in effect, are carried out by the ASCS, through its State and county offices, under authorities of the Food and Agriculture Act of 1977, as amended, and the Agricultural Adjustment Act of 1938, as amended. These programs include set-aside and other cropland diversion provisions, along with acreage allotments and marketing quotas for specified crops.

The 1977 Act continued the cropland set-aside approach, with revisions; substituted national program acreage for the acreage allotment system, except for rice; established authority for the farmer-owned grain reserve; established new limits on the amount of payment a person can receive annually under the program; and continued authority for the Secretary to permit producers to divert cropland acreage in addition to set-aside requirements and to make payments on this additional diversion.

The Production Adjustment Programs are designed to protect and improve farm income, give farmers more opportunity for decision-making on their farms, keep agricultural production in line with anticipated needs, and help assure that both farmers and consumers are equitably considered in the marketplace.

In line with these objectives, the Secretary of Agriculture is required to provide for a set-aside of cropland if it is determined that the total supply of wheat, feed grains, upland cotton, or rice will, in the absence of such set-aside, likely be excessive, taking into account domestic and export needs and any additional stocks required to maintain reasonable and stable supplies and prices and to meet a national emergency. Set-aside provisions are applicable under the same general conditions for each crop.

If a set-aside for a commodity is in effect, producers must comply with set-aside provisions in order to be eligible for loans, purchases, and payments. Producers on a farm must set aside and devote to approved conservation uses an acreage of cropland equal to a specified percentage of the acreage planted for harvest.

Land diversion payments may be authorized for wheat, feed grains, upland cotton, and rice, if the Secretary determines that such payments are necessary to assist in adjusting the total national acreage to desirable goals, whether or not a set-aside of these crops is in effect.

Loans on eligible commodities are made to producers through ASCS county offices and approved cooperatives. The loans are "nonrecourse"--if market prices rise above the loan level, the producer can pay off the loan, with interest, and sell the crop on the market. If prices fall below the loan level, the producer can turn the commodity over to CCC in full payment of the loan. Price support on tobacco, peanuts, and naval stores is made through producer associations acting for individual producers.

Target prices are based on costs of production rather than on parity price.

Target prices are in effect for wheat, corn, sorghum, barley, upland cotton, and rice. Whenever average farm prices during a specified period are below the announced target price, payments are made to participating farmers at rates equal to the difference between the target price and the higher of the average price or the loan level.

C. Agricultural Conservation Program

The Agricultural Conservation Program (ACP) provides a cost-share incentive to farmers and ranchers to carry out measures that:

- (1) control erosion and sedimentation from agricultural land and conserve the water resources on such land;
- (2) control pollution from animal wastes;
- (3) conserve wildlife habitat;
- (4) facilitate sound resource management systems through soil and water conservation;
- (5) encourage voluntary compliance by agricultural producers with Federal and State requirements to solve point and nonpoint sources of pollution (sources that originate on the farm or ranch);
- (6) reflect national priorities in the National Environmental Policy Act of 1969 and other congressional and administrative actions;
- (7) contribute to the national objective of assuring a continuous supply of food and fiber necessary for the maintenance of a strong and healthy people and economy; and that
- (8) assure the type of conservation measures needed to improve water quality in rural America.

In general, set-aside or diverted acres must be cropland that was tilled in at least one of the last three years, harvested for hay in all three preceding years in rotation with small grains or row crops, or was set aside or diverted acreage the previous crop year. The determination of acreage eligibility rests with the ASCS county committee.

Marketing quotas and acreage allotments are authorized under the Agricultural Adjustment Act of 1938, as amended, as a means of regulating the marketing of commodities when supplies are excessive.

The Secretary of Agriculture must proclaim national marketing quotas for designated crops when supply prospects exceed specified levels. Quotas are in effect only when approved by a two-thirds majority of the eligible producers voting in referendum. If approved, the quotas become mandatory for producers to be eligible for price support.

Acreage allotments and marketing quotas remain in effect only for peanuts, extra long staple cotton, and most kinds of tobacco, and allotments only for rice for payment and loan purposes.

The national marketing quota for a given commodity represents, in general, the quantity estimated to be required for domestic use and exports during the year. The national marketing quota is prorated directly to producing States and then prorated to individual farms on the basis of past production history.

B. Price Support Program

Price support to farmers is provided through commodity loans, payments, or other means for food grains (wheat, rice, and rye); feedgrains (corn, sorghum, barley, and oats); oil crops (soybeans, peanuts, and flaxseed); wool and mohair; and cotton, milk, tobacco, honey, and crude pine gum. The loan programs are financed by the Commodity Credit Corporation (CCC) and administered by the ASCS.

Price support assistance for wheat, rice, feedgrains, cotton, peanuts, and tobacco usually is contingent upon participation by the farmer in production adjustment programs. The price support level provided to farmers is set by statutory formulas. Methods include loans on crops held in storage by farmers, market purchases in times of excess supply, and supplemental payments to wool and mohair producers.

Milk prices are supported mainly by the buying of excess market supplies of dairy products, such as cheese, butter, and dry milk from processors.

The ACP is national in scope and is available for participation by all farmers and ranchers who, through consultation with others in the environmental field, establish the need for cost-share assistance in solving agricultural pollution and other resource conservation problems, with resulting benefits both long-term and communitywide. ACP is a joint effort by agricultural producers and the Government to restore, protect, and preserve the environment and our basic land resource.

The ACP is administered by ASC State, county, and community farmer committees. ASCS State and county offices serve as the focal points for the administration of the ACP. The Soil Conservation Service (SCS) and the Forest Service are responsible for providing technical program guidance to ASC committees as well as technical assistance to farmers in carrying out conservation practices.

To accomplish program objectives and to assure the program is tailored to best solve local needs, authority is delegated to the county ASC committee which consults with the county program development group to discuss and develop practices that will be included in the county program. This group includes Federal and State agencies and other groups interested in solving environmental and conservation problems. The State program development group will review the county program before it is implemented.

ACP funds authorized annually by Congress are allocated to the State ASC committee. The Secretary of Agriculture determines the amount of funds each State receives based on the State's soil and water conservation needs. The State ASC committee in turn allocates the funds to the county ASC committees who use these funds to enable local farmers to solve conservation problems on their land.

The ACP also helps provide required technical services for certain practices through special agreements with SCS, the State Forester, the county Cooperative Extension agent, and others.

To participate, the farmer files a request with the ASC county committee (at the ASCS county office) for ACP cost-sharing before carrying out the practice. The committee notifies the farmer of the extent of cost-sharing for which the request has been approved. Definite installation specifications which meet technical standards and local needs must be met if the practices are to qualify for ACP cost-sharing. After the practice is completed, the farmer certifies this to the county office. A farmer pays the total cost of establishing the approved practices and is later reimbursed for the Government's share of the cost.

Cost-sharing is available under annual or long-term agreements. Requests for long-term agreements can be accepted for complete farms for a period of 3 to 10 years or for a portion of a farm for a period of 3 to 5 years. Before any long-term agreement can be approved, the producer must indicate

a readiness to carry out a scheduled practice during the current program year. A conservation plan must be developed by a representative of SCS and approved by the Soil and Water Conservation District before final approval by the county ASC committee can be obtained.

Farmers or ranchers may enter into pooling agreements to jointly solve mutual conservation problems.

D. Forestry Incentives Program

The Forestry Incentives Program (FIP) was enacted as a result of congressional concern over expected shortage and rising prices of timber during the first twenty years of the 21st century. The objective of FIP is to increase the Nation's supply of timber products from private non-industrial forest lands. The purpose of the program is to encourage landowners to plant trees on suitable open lands or cutover areas and to perform timber stand improvement work for production of timber and other related forest resources.

The demand for wood in the United States is expected to exceed the supply within 30 years unless many more trees are planted each year and much more forest land is placed under good forest management. Private non-industrial landowners control the majority of forest lands in the Nation, but these lands are not fully utilized. Many landowners do not have the funds to make long-term investments in developing and improving forest areas. FIP is designed to share this expense with private, eligible landowners.

To meet the program objectives and to fully utilize available funds in a cost-effective manner, FIP is offered only in designated counties where a suitable number of ownerships are available that are capable of producing at least 50 cubic feet of timber per year. FIP agreements are limited to eligible ownerships of 10 to 1,000 acres. Landowners owning more than 1,000 but less than 5,000 acres may obtain an exception to this acreage limitation where the Secretary determines it is in the public interest.

FIP and its accomplishments are reviewed annually at the national, State, and county levels by the ASCS in consultation with the Forest Service (FS) and a committee of at least 5 State foresters or equivalent State officials. The program is jointly administered by ASCS and FS in cooperation with State forestry agencies. Cost-share requests and payments are administered by the ASCS county committees with technical forestry assistance provided by State forestry agencies. As required by the Act, the Secretary of Agriculture periodically reports to Congress on the progress of the program through a continuous evaluation of individual investments.

Funds for cost-share use are allocated in each program year to ASC State committees on the basis of a survey of total eligible private timber products. In addition, the ability of a given State to operate the program effectively is also considered.

The ASC State committee, in consultation with the State forester, develops a State FIP program that reflects the State's forestry needs; including a list of designated counties, eligible forestry practices, applicable cost-share rates, and the requirements, conditions, and specifications for the practices.

The State program is submitted to the national level for review and approval. Once the State program is approved, the State ASC committee allots the funds to the ASC county committees who use them to help landowners apply forestry practices on their land.

Program objectives are accomplished by providing cost-share payments and technical assistance to private, non-industrial forest landowners for approved tree planting and timber stand improvement practices. Cost-share agreements between the landowner and the Secretary are based on forest management plans developed by the landowner in cooperation with and approved by the State forestry agency. In development and application of the plan, adequate consideration will be given to enhancing other related forest resources as well as cost-effective timber production.

Landowners apply for participation in the program at the county Agricultural Stabilization and Conservation (ASC) office which asks the State forestry agency to examine the property, develop the Forest Management Plan (if needed), and certify the need for the proposed practice. The State forestry agency provides technical advice and will help locate approved vendors for getting the work accomplished. The State forestry agency must certify that the project has been completed satisfactorily in accordance with the approved plan before payment is made.

The county ASCS office handles all payments earned under the program.

FIP also provides for help in obtaining required technical service for forestry practices through special arrangements with the U.S. Forest Service and the State foresters.

Cost-sharing assistance cannot exceed 75 percent of the actual, average, or estimated cost of performing the practice, as determined jointly by the State Forester and the State and county ASC committee. In some States, assistance is available under long-term agreements of 3 to 10 years.

E. Water Bank Program

The Water Bank Program is available to farmers or ranchers having specified types of wetlands along major migratory waterfowl flyways. The Agricultural Stabilization and Conservation Service operates the program primarily along the northern part of the Mississippi River and along north-south flyways. The program is designed to preserve and improve migratory waterfowl and other wildlife habitat; preserve and improve wetlands; conserve surface waters; reduce runoff, soil erosion, and stream sedimentation; contribute to flood control, better water quality, and improved subsurface moisture; and accomplish related conservation and environmental objectives.

Farm and ranch owners and operators may enter into 10-year agreements, with provision for adjustment of rental rates the fifth year of the agreement, and for renewal at the end of the 10-year period. Owners and operators receive annual payments to meet the purposes of the program.

ASC county committees administer the program. Planning and technical services are provided by the Soil Conservation Service.

F. Rural Clean Water Program

The Rural Clean Water Program (RCWP), administered by the Agricultural Stabilization and Conservation Service, is an experimental program designed as a cooperative endeavor to develop and test policies, procedures, and methods for controlling agricultural sources of pollution. This program treats specific types of water quality problems: runoff containing nutrients and/or pesticides, animal waste, leachates, irrigation return flows, and sediment. The Soil Conservation Service is responsible for coordinating technical assistance provided in the RCWP.

This voluntary program provides long term financial and technical assistance to owners and operators of privately held agricultural land in selected project areas who install conservation measures to control water pollution. Local authority under the program is delegated to the county ASC committee. Each RCWP project has a Local Coordinating Committee (LCC) which is chaired by the chairperson of the county ASC committee. Included on the LCC are Federal, State, and county agencies, and other organizations interested in improving water quality. The Soil Conservation Service, Forest Service, Cooperative Extension Service, and others provide technical assistance to farmers in carrying out their water quality improvement plans.

G. Grain Reserve Program

The Food and Agriculture Act of 1977 provides for a producer storage program for wheat and feedgrains by providing original or extended price support loans repayable in 3 to 5 years. Producers receive annual payments in advance from the Commodity Credit Corporation to help pay for the costs of reserve storage. Producers who grow wheat, corn, barley, sorghum, or oats can participate in the ASCS administered program. These crops must be under a CCC price support loan to be eligible for the reserve program. Grain placed into the reserve is subject to the same storage requirements as grain in the regular price support loan program. The farmer agrees not to sell grain in the reserve until national average market prices reach predetermined release levels. Once these levels are reached, the producer may repay the reserve loan and sell the grain without penalty. Producers who sell grain in the reserve before this "release" date are required to pay an early redemption charge in order to ensure effectiveness of the reserve program. When the national average market prices reach predetermined levels, reserve loans will be called. The "call" level is not a ceiling over market prices. After the reserve loan is repaid, the producer is not required to sell the grain but may hold for higher prices.

H. Farm Facility Loan Program

Assistance through loans is available to producers of grain, soybeans, rice, high moisture forage and silage, and certain other agricultural commodities for the construction of on-farm storage and drying facilities. The maximum loan amount is 85 percent of the cost of the structures and equipment, not to exceed \$100,000. The maximum loan term is 8 years and the interest rate is based on the rate charged the Commodity Credit Corporation by the U.S. Treasury.

Farmers and ranchers may apply for the loans through their county ASC office and the CCC.

I. Emergency Conservation Program

The ASCS Emergency Conservation Program (ECP) provides emergency funds for sharing with farmers and ranchers the cost of emergency conservation measures needed to rehabilitate farmland damaged by wind erosion, floods, hurricanes, or other natural disasters, and for carrying out emergency water conservation measures during periods of severe drought. A farmer or rancher who qualifies may receive up to 80 percent of the cost of the measures.

Subject to availability of funds, the ASC county committee in consultation

with the State ASC committee is authorized to implement the ECP for eligible farmers and ranchers when the damage is so costly to repair that Federal assistance is needed to return the land to productive agricultural use.

J. Emergency Feed Program

Emergency assistance to provide feed for livestock producers who have suffered an unusual loss of feed because of a disaster is available through the ASCS. This program is also available to provide feed for wildlife where forage is limited due to a disaster.

The programs are administered through State and county Agricultural Stabilization and Conservation offices. Program explanations as they may affect individual counties may be obtained at the county ASCS office.

The purpose of the Emergency Feed Program is to reimburse livestock owners for a portion of the cost of feed purchased during an emergency in which they suffered substantial loss of feed production for their livestock due to a natural disaster.

Eligible livestock includes beef and dairy cattle, horses, mules, sheep, goats, and swine. Buffalo and beefalo are also included when maintained on the same basis as beef cattle in support of the beef industry. Natural disasters include flood, drought, fire, or other natural disaster, including excessive rain, hail, and high winds. Benefits are available to any owner of livestock maintained in the United States or its possessions who has suffered, during the crop year, a substantial loss of livestock feed normally produced on land owned or operated by the livestock owner, on condition that the owner does not have sufficient feed for the livestock, and the owner is required to purchase a quantity of feed greater than normal.

K. Emergency Harvesting Program

Following a decision by the Administrator of the ASCS, emergency harvesting may be authorized on set-aside or diverted acreage following a loss of feed supply due to a natural disaster.

Farmers and ranchers can apply for emergency harvesting through their county ASC offices.

L. Disaster Payment Program

Farmers producing wheat, feed grains, rice, or upland cotton may be eligible for payments from the ASCS if they are prevented from planting one or more of these program crops or if their yields are substantially reduced due to a natural disaster.

M. Indian Acute Distress Donation Program

Commodity Credit Corporation - owned feed grains may be donated to Indian tribes for livestock feeding following a decision by the Administrator of the ASCS that the chronic acute distress of the needy members of an Indian tribe has been materially increased due to severe drought, flood, hurricane, blizzard, or other catastrophe. Distribution of feed to the tribe is arranged by the Bureau of Indian Affairs, Department of the Interior.

N. Migratory Wildfowl Feeding Program

CCC-owned grain may be donated to the Department of the Interior, following a decision by the Administrator of the ASCS and the Secretary of the Interior, for feeding migratory waterfowl when threatened with starvation or for prevention of crop damage.

O. Resident Wildlife Feeding Program

CCC-owned grain may also be donated to State agencies for feeding resident wildlife threatened with serious damage or loss from starvation, upon the request of the Administrator of the ASCS and authorization by the Secretary of the Interior.

P. Defense Program

Defense programs are aimed at maintaining preparedness of production, conservation, and stabilization. Office managers for the ASCS serve on state and county civil defense boards and provide directions for keeping agriculture prepared for emergencies.

4. ASCS Program Organization

Transparency No. 3

State, county, and community Agricultural Stabilization and Conservation (ASC) committees, made up of members who are actively engaged in farming, administer the programs and activities of the Agricultural Stabilization and Conservation Service (ASCS) and the field operations of the Commodity Credit Corporation (CCC).

These committees were established under the Soil Conservation and Domestic Allotment Act of 1935, as amended. Since 1933, however, farmers had a central role in making farm program decisions, at first through representation by members and leaders of farm organizations and by State and local agricultural officials.

The Agricultural Adjustment Act of 1933 authorized the Secretary of Agriculture to establish "State or local committees or associations of producers to act as agents of their members and patrons in connection with distribution of rental or benefit payments." The early committees--cotton, wheat, corn-hog, etc.--were formed whenever the commodity was produced as a major crop. In some States and counties, several committees functioned at the same time.

Local farmers, acquainted with the farms and farming patterns of the community, were considered most capable of making decisions regarding the administration of farm programs. In order to insure against any partisan or organizational domination of the programs, provision was made for the annual election of local committee members by farmers. The early State committees were appointed by the Secretary of Agriculture in the same manner as they are today.

Following approval of the 1935 Act, as amended, the various commodity committees which had been established were eliminated, and a single farmer committee served all commodity groups in any one county.

The Agricultural Adjustment Act of 1938 mandated use of elected farmer committees for the first time. Among other provisions, the Act prescribed the general method of electing county committee members, the number of members, and the composition and method of selecting State farmer committee members.

As the committee system developed, full-time managers (today's State and County Executive Directors) were employed to supervise, under committee direction, day-to-day program operations through ASCS State and county offices.

ASC State committees are composed of three to five members appointed by the Secretary of Agriculture. The Director of the Agricultural Extension Service is an ex officio member of the committee.

The State committee is responsible for the administration of farm programs in each State and for general supervision of the work of county committees. Each State committee appoints a State Executive Director who supervises and directs the work of the State office staff under policies established by the committee.

ASC county and community committee members are elected by other farmers in the county or community. There are over 3,000 county committees (one for each "agricultural county" in the Nation) and 16,000 community committees. There are no ASCS county offices or ASC committees in Puerto Rico or the Virgin Islands.

A county committee is made up of three regular members (each of whom serves a staggered 3-year term) and two alternate members (both usually elected each year). The county agricultural extension agent is a non-voting ex officio member of the committee. Each ASC county committee employs a County Executive

Director who, for the committee, hires the necessary employees to staff the office and is responsible for day-to-day office and field operations. The county committee is responsible for program and administrative policies, decisions, and program reviews at the county level.

Community committees assist the county committee in carrying out program administration. Community committees of three regular and two alternate members each are elected by direct vote of the farmers in each of several local communities within the county. In these multiple community counties, the community committees in each county hold a convention following their election to nominate and elect the county committee members. All regular community committee members (excluding alternates) are delegates to the convention.

In one-community counties, county committee members are elected by direct vote of the farmers, and the county committee serves as the community committee.

In the election of both county and community committee members, the farmer receiving the largest number of votes becomes the chairperson; second largest, vice chairperson; third largest, regular member; and fourth and fifth largest, first and second alternates. Alternate committee members serve in the place of committee members who for any reason cannot serve either temporarily or permanently.

To hold office as a county or community committee member, a person must be eligible to vote in the committee elections, must reside in the county or community, and must meet certain other minimum requirements designed primarily to insure that political activity is in no way involved in committee decisions or operations.

A petition signed by three eligible voters is needed to nominate a farmer-candidate who has agreed to run. There is no limit to the number of petitions a person may sign, but each county or community should nominate at least six candidates. If enough candidates are not nominated by petition, the current county or community committee will make nominations to bring the number of candidates up to the required minimum number. One of the committee's nominees must be from a minority group if a county or community has 10 percent or more minority farmers and none were nominated by petition.

In general, those eligible to vote in the annual ASC committee elections are persons of legal voting age who have an interest in a farm as owner, tenant, or sharecropper, and who are participating or are eligible to participate in the programs administered by the committee. A person under 18 who operates a farm is also eligible to vote. A legal guardian who runs a farm for a child can vote for the child. Both husband and wife can vote in Arizona, California, Idaho, Louisiana, Nevada, New Mexico, Texas, and Washington, even though only one

is listed as owner, operator, tenant, or sharecropper. In any state, a spouse is eligible to vote if that person is a bonafide joint owner, operator, tenant, or sharecropper.

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No. 1 - "Agricultural Stabilization and Conservation Service," October, 1978.

No. 3 - "Farmer Committee Administration of Agricultural Programs," October, 1978.

No. 6 - "Production Adjustment Programs," September, 1979.

No. 7 - "Emergency Feed Assistance Programs," October, 1978.

No. 10 - "Agricultural Conservation Program," October, 1978.

No. 11 - "Forestry Incentives Program," March, 1979.

GLOSSARY OF TERMS

Acreage allotment - the individual farm's share, based on its previous production of the national acreage needed to produce sufficient supplies of a particular crop.

Basic commodity - one of the six agricultural crops (cotton, peanuts, rice, tobacco, corn, and other feed grains) declared by legislation as requiring price support.

Marketing quota - the quantity of a basic commodity that will provide adequate and normal market supplies. This quantity is translated into terms of acreage needed to grow that amount and allotted among individual farms, based on their previous production of that commodity.

Naval store - a product, such as turpentine and rosin, obtained from the distillation of crude pine gum.

Nonrecourse loan - a price support loan to farmers to enable them to hold their crops for later sale. Farmers may redeem their loans by paying them off with interest. The loans are nonrecourse because if a farmer cannot profitably sell the commodity and repay the loan when it matures, the pledged or mortgaged collateral (the commodity on which the loan was advanced) can be delivered to the Government for settlement of the loan.

Parity price - the price per bushel (or pound or bale) that would be necessary for a bushel today to buy the same quantity of goods (from a standard list) that a bushel would have bought in the 1910 - 14 base period at the prices then prevailing.

Price support level - the price for a unit of a farm commodity (bushel, pound, bale) which the government will support through price support payments. Price support levels are determined by law and are set by the Secretary of Agriculture.

Set-aside - a Government farm program term used to designate the proportion of a farmer's cropland acreage that the farmer must plant to soil conserving uses (such as grasses, legumes, and small grain which is not allowed to mature) in order to be eligible for price support payments and loans.

Target price - a minimum level of the commodity market price determined by law to be adequate for farmers to meet the cost of production. It is sometimes called the "guaranteed price level." The target price becomes the price support level at which the government will bolster farm income by making price support payments to qualifying farmers when national average market prices fall below the target.

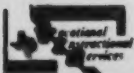
Upland cotton - a fiber plant developed in the U.S. from stock native to Mexico and Central America. The staple length of upland cotton ranges from 3/4 inch to 1 1/4 inches. Sea Island and American Pima cotton are not classified as upland cotton.

PRINCIPAL ACTIVITIES OF A.S.C.S.

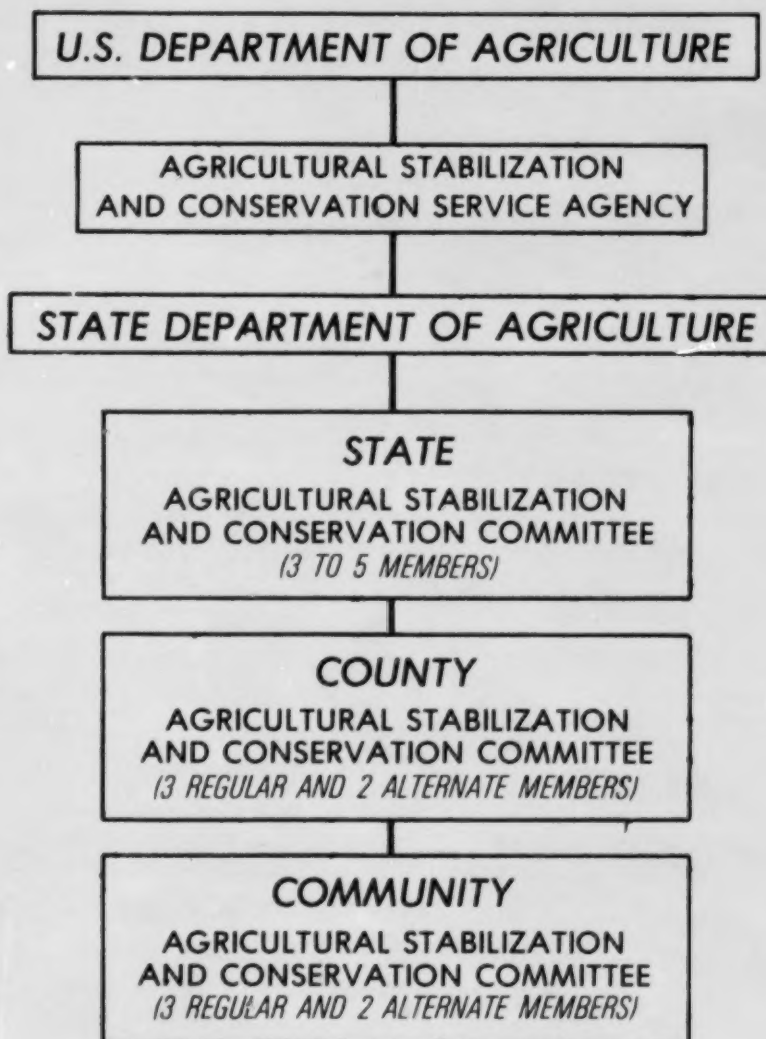
1. PRICE SUPPORT
2. PRODUCTION ADJUSTMENT
3. CONSERVATION AND LAND USE ADJUSTMENT
4. MANAGEMENT AND INVENTORY OF COMMODITY CREDIT CORPORATION
5. DISASTER AND EMERGENCY RELIEF
6. GRAIN RESERVE

PROGRAMS OF A.S.C.S.

- A. PRODUCTION ADJUSTMENT PROGRAM**
- B. PRICE SUPPORT PROGRAM**
- C. AGRICULTURAL CONSERVATION PROGRAM**
- D. FORESTRY INCENTIVES PROGRAM**
- E. WATER BANK PROGRAM**
- F. RURAL CLEAN WATER PROGRAM**
- G. GRAIN RESERVE PROGRAM**
- H. FARM FACILITY LOAN PROGRAM**
- I. EMERGENCY CONSERVATION PROGRAM**
- J. EMERGENCY FEED PROGRAM**
- K. EMERGENCY HARVESTING PROGRAM**
- L. DISASTER PAYMENT PROGRAM**
- M. INDIAN ACUTE DISTRESS DONATION PROGRAM**
- N. MIGRATORY WILDFOWL FEEDING PROGRAM**
- O. RESIDENT WILDLIFE FEEDING PROGRAM**
- P. DEFENSE PROGRAM**



A.S.C.S. PROGRAM ORGANIZATION



SOIL SCIENCE

Unit C: Agencies Assisting in Soil and Water Conservation

Topic 3: Soil and Water Conservation Districts

Suggested Procedures and Activities: (1) Invite a member of the Board of Directors of the SWCD in which the school is located to visit the class to explain the operation of the SWCD. (2) Obtain copies of the SWCD's Program of Work for class study and discussion.

1. Introduction - "What They Are"

Soil and Water Conservation Districts (SWCDs) blanket the nation. They include about 95 percent of the farms and ranches and more than 90 percent of the agricultural land in the United States. The first conservation district was formed in 1937. Since then, conservation district legislation has been enacted in all 50 states plus Puerto Rico and the Virgin Islands. Over 3,000 districts are now in operation. Each state has a Soil and Water Conservation Commission or committee which approves the establishment of local soil and water conservation districts governed by local boards of supervisors, directors, or commissioners. Local districts invite the assistance of the Soil Conservation Service in making farm conservation plans. Near each local SWCD is a Soil Conservation Service office working under the direction of the State Soil Conservation Office.

Transparency No. 1

The SWCDs in Texas are divided into five zones. These zones are further divided into 199 districts. The work of these soil conservation districts is administered by 995 district directors who work with over 100,000 landowner cooperators operating approximately 100 million acres. (Point out the location of the soil conservation district in which your county is located. This would be a good time to acquaint the students with the local SCS and SWCD workers.)

2. Organization of the Soil and Water Conservation Districts - "How They Work"

A soil and water conservation district is brought into existence by a vote of the landowners within the boundaries of the proposed district. Soil and water conservation districts are legally constituted units or instrumentalities of state government created to administer soil and water conservation work within their boundaries. They are not branches or agencies of any federal department.

Units of Local Government

Each district is autonomous (independent) and self governed. It has authority to enter into working agreements with other governmental agencies and with private concerns to carry out its purposes. A soil and water conservation district is a subdivision of the state government. It is completely independent of the federal government or any part of the state government. Other than the law under which it was created, it answers to no individual or agency.

Each district is created by legal procedures under authority of the state law. These laws differ in different states, but they have much in common. All are based on the principle that local landowners and operators should take the initiative and responsibility in directing conservation problems aimed at solving local soil and water problems.

In most states, each district is created after petitions, public hearings, and a referendum show that landowners and operators want such a local agency to deal with their conservation problems. Once established, a soil and water conservation district is legally responsible for soil and water conservation within its territory (just as a county is responsible for roads and as a school district is for education).

Each soil and water conservation district is directed by a board of local people, usually resident landowners or operators, who are elected or locally designated. In most states these are called directors. Texas community property laws allow the spouse of a landowner to vote in director elections and to hold office as a district director. The board of directors decides upon a district-wide program and plan of action. It then arranges for assistance from public or private sources to put its program into effect. This assistance is directed to help farmers and ranchers further their individual conservation plans.

Transparency No. 2

To keep the reins tight and to assure equal representation on the district's governing board, soil conservation districts are subdivided into five zones. A district's governing board, called a Board of Directors, is made up of five landowners (one from each of the five zones). Each district supervisor must live in the district, own land in the zone he or she represents, and be actively engaged in farming or ranching through their elected directors.

Directors are elected for a five-year term. Each year, landowners from one zone in each of the 199 districts over the state assemble in conventions and elect their representative on the District's Board of Directors. By rotating the elections among the five zones, one new director is elected each year to replace the director whose term is expiring. Only resident landowners (and spouses in community property states) may vote or qualify as directors.

District directors receive no salary. They do, however, receive reimbursement for travel expenses to SWCD meetings. Ordinarily the directors meet once a month, but outside of these meetings, they have numerous other meetings for which they receive no pay.

3. Working Agreements

The state laws authorize soil and water conservation districts to own property, to accept materials and services, and to use and manage them to further their conservation objectives. Most districts arrange for the services of public agencies and private organizations through formal working agreements.

Transparency No. 3

District Program

After a district has been fully organized, it becomes the responsibility of the newly-elected board of directors to develop a program of work. This program is actually an inventory of the land and water resources and problems of the district. It describes the actual conditions affecting the land and its use. The district's soil and water conservation goals are stated including the means of attaining the goals.

The program is prepared by the directors after consulting with local citizens and considering technical information furnished by the Department of Agriculture, state agencies, and other sources.

Agency Assistance to Districts

Assistance goes to a soil and water conservation district after it is fully organized and ready to operate. Its program is sent to the Secretary of Agriculture in Washington and to numerous state agencies capable of assisting a soil and water conservation district. The Secretary of Agriculture and the state agencies are requested to enter into Memorandums of Understanding with the local district. The state and federal governments agree to assist the district's governing body in carrying out the district's program of work. After the Secretary of Agriculture signs a district's Memorandum of Understanding, any USDA agency is authorized to help the district.

Under the SWCD plan, the Soil Conservation Service renders technical assistance; the Extension Service (Land Grant Colleges, State and County Extension Agents) and Vocational Agricultural Education programs (Vocational Agriculture Teachers) provide educational assistance; the Farmers Home Administration makes loans available for facilities or services; ASCS committees assist in developing county agricultural conservation programs; and other agencies offer assistance in their respective fields.

Farm and Ranch Plans

The main objective of all soil and water conservation districts is to have a complete soil and water conservation program in effect on every farm or ranch within its boundaries. As land users take care of their own acreage, the goal of community-wide conservation is attained. (The Farm and Ranch Conservation Plan is discussed in Unit A, Topic 3.)

Small Watershed Projects

Soil and water conservation districts are the principal means for local administration of small watershed projects under the Watershed Protection and Flood Prevention Act and its amendments.

The Watershed Protection Act authorizes the Department of Agriculture to assist local organizations with watershed-protection and flood-prevention projects on areas of no more than 250,000 acres. The Department can provide technical assistance, cost sharing, and credit. The Soil Conservation Service has primary responsibility for carrying out the Act.

When the soil and water conservation district lacks legal authority or financial means to administer the project alone, it arranges with other local governmental subdivisions to assume specific responsibilities.

Finances

Soil and water conservation district operations are financed by state and county appropriations, by money earned by the districts themselves, and by contributions from private sources.

Cooperators bear most of the cost of practices installed on their land. The cost of certain practices of public benefit may be shared by the federal government through the Agricultural Conservation Program, the Great Plains Conservation Program, and similar programs. Technical services are provided without charge by the Soil Conservation Service.

State legislatures appropriate funds for the state soil and water conservation committees. Many states make funds available for allotment to districts for purchasing equipment and machinery, for hiring clerical and sub-professional help, and for other operating costs.

The amount of state, local, and private funds contributed to soil and water conservation districts is about a third of the amount appropriated by legislation.

It is not the intention of soil and water conservation districts to give or receive something for nothing. They strive to install in the minds of the people that it is their responsibility to do the job of soil conservation. Upon request, soil conservation districts provide aid from many sources. But even with assistance, farmers and ranchers must exercise the initiative to apply conservation programs.

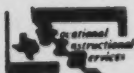
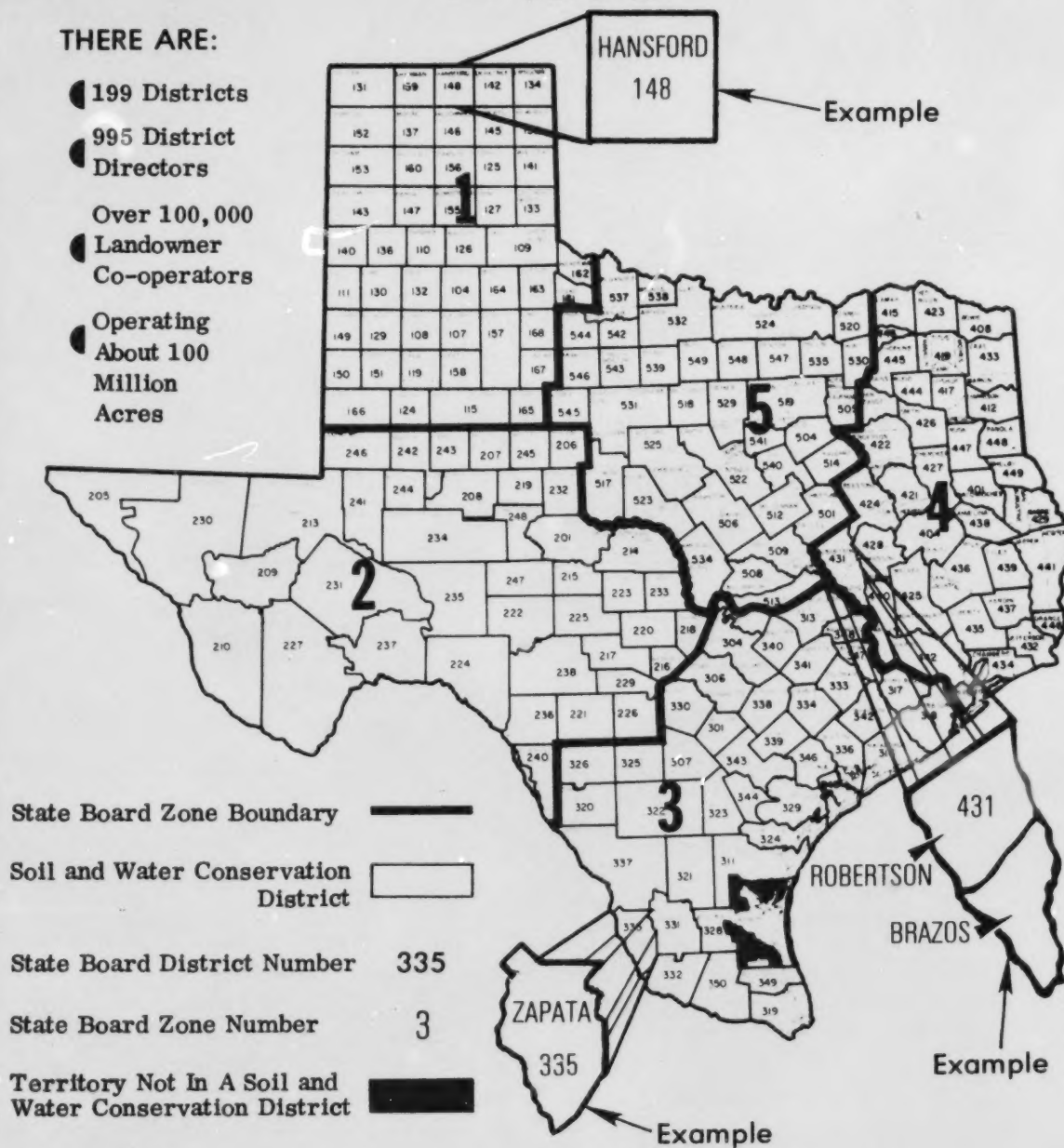
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2. Knuti, Leo L., Milton Korpi, and J. C. Hide, Profitable Soil Management, 2nd. ed., Prentice-Hall, Inc., Englewood Cliffs, N.J., 1970, pp. 254-256.
3. "Our American Land," Bulletin 321, U.S.D.A., S.C.S., Washington, D.C., 1973.
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SOIL AND WATER CONSERVATION DISTRICTS IN TEXAS

THERE ARE:

- 199 Districts
- 995 District Directors
- Over 100,000 Landowner Co-operators
- Operating About 100 Million Acres



V. A. III

337

III-C-3
No. 1

GRASSROOTS GOVERNMENT



EQUAL REPRESENTATION IS ASSURED

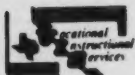
BRAZOS-ROBERTSON
SOIL CONSERVATION DISTRICT

NO. 431



PROGRAM AND PLAN

P.O. BOX 792
BRYAN, TEXAS



V. A. III

339

III-C-3
No. 3

SOIL SCIENCE

Unit C: Agencies Assisting in Soil and Water Conservation

Topic 4: Watershed Districts

Suggested Procedures and Activities: Invite the local SCS Supervisor to discuss watershed projects with the class. If a flood control structure or watershed project has been constructed in the area, visit the location to observe the work performed.

1. What Is a Watershed?

Transparency No. 1

Watershed is a new term to many people. The increasing use of soil and water conservation measures for watershed protection and flood prevention is bringing the term into more common use. A watershed is all of the land that drains into a common stream. This common stream may be a tributary, creek, or river. The size of a watershed may range from a few thousand acres, in the case of a tributary, or several hundred thousand, in the case of a river. On the land, water that does not evaporate or soak into the soil usually drains into ditches, streams, marshes, or lakes. The land area from which the water drains to a given point is the watershed.

2. Why Plan Watersheds?

There is growing concern everywhere over water supplies for agriculture, as well as for urban and industrial uses. Water is often the limiting factor in industrial expansion, and shortages are creating serious problems for our growing population.

Transparency No. 2

A definite plan for a watershed will insure that water is available for all people's needs. Often a watershed is planned solely for power, flood prevention, or recreation. With comprehensive planning, the same watershed could serve all of these needs in a systematic way.

A well-planned watershed can result in improvements, such as increased income, additional services, facilities for enjoying leisure, or the protection of property.

The Small Watershed Program (Public Law 566) provides opportunity for city and farm people to work together in the protection of land, development of

water supplies, flood prevention, protection of fish and wildlife, and recreation. Average damage from floods and sediment in the United States exceeds a billion dollars a year. One-half of this damage occurs in the small upstream watersheds.

3. Assistance Available for Watershed Development

Many state and federal programs and agencies are available to help develop a watershed.

Board of Water Engineers, State of Texas

This board has the responsibility of carrying out the right and duty of the state in developing and conserving the water resources of Texas. The Board acts upon applications to divert and store water and approves the plans of federal projects. The Board has the power to condemn existing water works that may become a public menace as well as issue and cancel permits. The State Board of Water Engineers is located in Austin.

Texas Water Development Board

This board can assist in financing water development by approving loans. These are made on bonds and other securities that are subordinate to other bonds or securities issued by the local group to finance the same project. The Texas Water Development Board is located in Austin.

Watershed Protection and Flood Prevention Act (Public Law 566)

This Act provides for cost sharing between the federal government and the responsible local government in small watershed development. The primary purpose of this Act is to provide federal assistance to local people who need and desire aid in carrying out projects for the prevention of floods, erosion, and siltation on small watersheds. Public Law 1018 makes possible the storage of water for municipal or industrial use, provided no structure will store more than 25,000 acre feet.

The federal government, through the Soil Conservation Service, pays for all approved construction and engineering costs for works of improvements applicable to flood prevention and watershed protection. Local people bear the entire cost of expansion of structures. Information about provisions of this act is available from the local County Agent, Soil Conservation Service, or Soil Conservation District. The Texas State Soil Conservation Board, Temple, has been designated as the State approval authority.

Farmers Home Administration

This agency makes loans to finance the local share of costs in carrying out works of improvements authorized under Public Law 566. The loans are repayable

within 50 years (Texas statutes permit only a 40-year repayment period) at a rate of interest determined by the Secretary of the Treasury. The maximum loan is 5 million dollars for any single plan for works of improvement. In addition to the watershed loan, the Farmers Home Administration is authorized to make soil and water conservation loans to local subdivisions. These loans may be used for materials, equipment, machinery, installation, and construction costs. Specific information concerning loans is available from local FmFA offices.

Texas A&M University

The Texas Agricultural Extension Service, Texas Agricultural Experiment Station, Texas Engineering Extension Service, Texas Engineering Experiment Station, and the Texas Water Resources Institute can help with water development programs. Research information, planning, and educational services are available through these parts of the University. (For information on such services, contact the local County Agricultural Agent.)

Private Enterprise and Local Cooperation

Many excellent water development projects have been accomplished by local cooperation and private enterprise, mainly out of the desire of local people to have lakeshore property. These developments serve an economic need for municipal and industrial expansion. Examples of this type of water development are Lake Cherokee, Longview; Camp Creek, Bryan; and Lake Jacksonville, Jacksonville.

Other Sources

Many water development problems individuals may have are not new. Help is available from experienced people at the nearest water district; Corps of Army Engineers, Fort Worth; Bureau of Reclamation, Austin; the River Authority which has jurisdiction over your area; Soil Conservation Service, Temple; or your county commissioners' court.

4. Watershed Projects

The Watershed Protection and Flood Prevention Act authorizes the Secretary of Agriculture to cooperate with local organizations in planning and constructing watershed protection structures. Technical and financial assistance is provided by the U.S.D. A. to local organizations or states. These local groups are required to meet certain standards in order to qualify for federal assistance.

Transparency No. 3

Sound plans are essential to constructive action. The first step in a watershed protection program is the preparation of a watershed plan. All local interests have their opportunity to participate in preparing the plan. The plans will reveal the kinds, quantities, and costs of all needed soil and water measures. They will show the specific location of major water management measures such as flood-water-retarding structures and channel improvements.

After preparation and approval of the watershed plan by Federal, State, and local agencies, designs and specifications for the necessary structural phases of the program are completed. This is followed by the application, installation, and construction of recommended measures.

As already indicated, a successful watershed protection program requires that local interests assume principal responsibility of the program. This necessitates the sponsorship of a soil conservation district together with other responsible local organizations. It is also mandatory that local interests share a part of the watershed cost by providing easements and rights-of-way for structural measures including land treatment practices.

Finally, the operation and maintenance of the program should be carefully observed for its effectiveness in accomplishing the objectives of watershed protection. Because land and the behavior of water falling on land differs from area to area, each watershed and each land type in every watershed must be individually planned and evaluated.

Transparency No. 4

In addition to meeting federal standards for a watershed, local sponsors may need to possess authority to qualify for a watershed project. They should have the "power to finance" and the "power to regulate" the watershed.

Power to Finance

If local groups are to assume responsibilities for their watershed programs, they will need to raise funds:

To pay initial expenses - Local groups will incur expenses to start a program. They will need to make flood damage surveys and provide administrative funds. These expenses will be incurred before special assessments can be levied. One way to meet these early expenses is by assessing a small general property tax; another way would be by accepting local donations.

To pay for installations - This will be a large expense, and the district will probably have to borrow money for financing. Recent amendments have allowed the Secretary of Agriculture to make loans or advancements to these groups.

To pay for operation and maintenance - Many districts provide just enough money for construction and not enough for maintenance which limits the effectiveness of the project. Donations can be accepted, but the best means of financing is through an annual tax levy.

To provide for replacements - Some structures will eventually have to be replaced because they will have been damaged or have served their useful life. For these reasons a sinking fund should be established.

Limitations of tax levies - Most people are very tax conscious. However, the tax rate should be high enough to adequately finance the project.

Power to Regulate

Land use regulations - The sponsors should enter into an agreement with the individual landowners as to what work will be done on their property. A basis for settlement of any damages should be agreed upon.

Zoning ordinances - The main objective is to reduce flood damage. Zoning ordinances should clearly state the way the land is to be used, density of population, and construction of buildings. These powers can be granted to a watershed district or could be made available by other enabling acts.

Other Powers

A local organization may need other powers to be effective in the development of a watershed program. Among these are the powers to:

- a. Make surveys and adopt plans for improvement,
- b. Cooperate and contract with other governmental units,
- c. Exercise power of eminent domain,
- d. Change boundaries or merge with other districts,
- e. Sue and be sued,
- f. Accept gifts,
- g. Hire and discharge employees, and
- h. Establish rules of business.

Many items must be considered when developing enabling legislation for watershed districts. If a district is desired, one can be established by legislation. The requirements as specified by legislation are:

A petition - The minimum petition will include:

- a. Name of proposed district
- b. Proposal boundaries on a map
- c. Name of counties involved

- d. Statement of purpose and improvements to be made
- e. Name and address of original directors
- f. Request for a vote

Filing - After the needed signatures are obtained, they will be filed with the County Clerk or local hearing agency.

Hearings - After the petition is filed, the landowners affected should be heard. Notice by publication should be circulated.

Election - This will determine whether a majority of the landowners are interested.

Governing body - As soon as the district is established, a board of directors should be elected.

Developing a Plan for the Watershed District

In preparing a plan, consider the following:

- a. How much description of the plan for development should be included in the petition for organization?
- b. Should the district be granted authority to prepare a comprehensive plan for the district?
- c. How many details on cost and benefits should be included?
- d. Should special assessments if any be contemplated?
- e. How much discretion should be given the board of directors in placing the program into operation?

5. Watershed Development in Texas

Many watershed districts have been formed in Texas. Although there are over 800 watersheds in the state, only about 260 of these are considered feasible for development. This means that over 140 million acres of land in Texas lack proper watershed development. Much of this land area is reduced to an economic standstill because of a lack of water. Add to this the water problems created by growth in population, industry, and irrigation farming.

What is the answer to future and present water problems in Texas? One answer lies with the people living in each watershed. They must become interested and take positive steps toward a solution.

References:

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2. Stallings, J. H., Soil Conservation, 1st. ed., Prentice-Hall, Inc., Englewood Cliffs, N.J., 1957, pp. 526-547.
3. "Surface Water Development in Texas," B-1177, Texas Agricultural Experiment Station, College Station, Texas, May, 1977.
4. "Watershed Development in Texas," MP-1124, Texas Agricultural Extension Service, College Station, Texas, April, 1974.

PRINCIPAL RIVER BASINS OF
DRAINAGE AREAS

A

ARKANSAS
WHITE
RED

- 19 Arkansas (Canadian)
- 20 Red

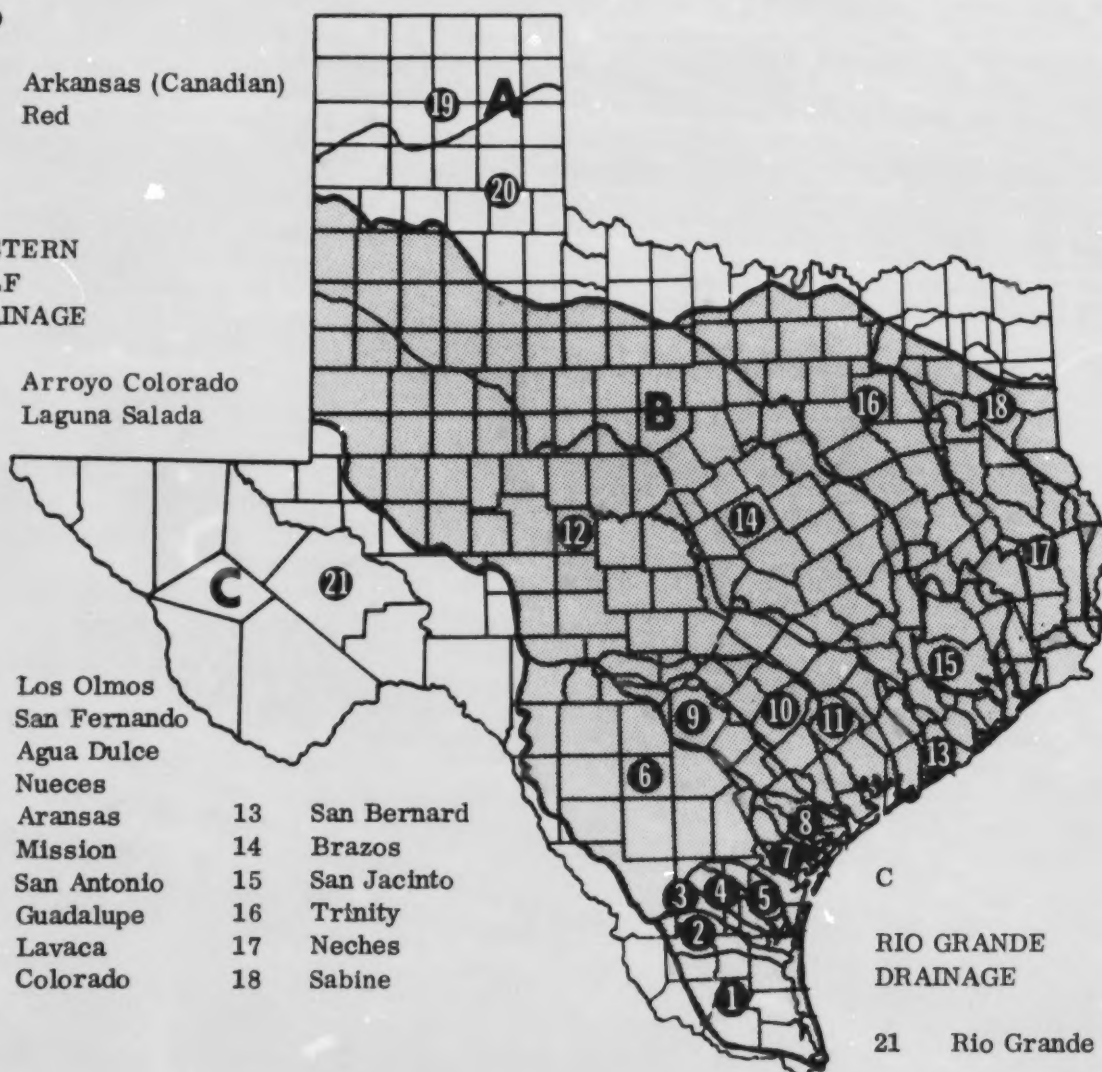
B

WESTERN
GULF
DRAINAGE

- 1 Arroyo Colorado
- 2 Laguna Salada

- | | |
|----------------|----------------|
| 3 Los Olmos | 13 San Bernard |
| 4 San Fernando | 14 Brazos |
| 5 Agua Dulce | 15 San Jacinto |
| 6 Nueces | 16 Trinity |
| 7 Aransas | 17 Neches |
| 8 Mission | 18 Sabine |
| 9 San Antonio | |
| 10 Guadalupe | |
| 11 Lavaca | |
| 12 Colorado | |

MAJOR DRAINAGE AREAS OF TEXAS



C
RIO GRANDE
DRAINAGE

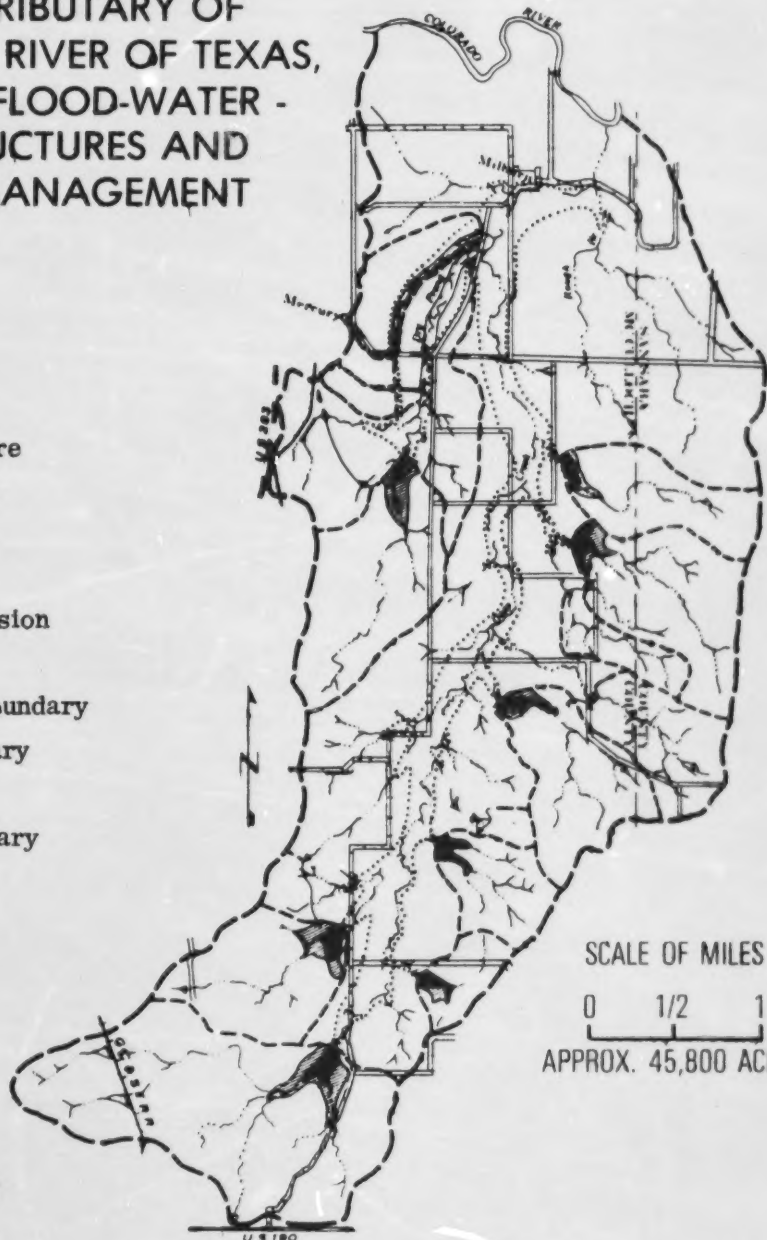
21 Rio Grande

WATERSHED MAP

DEEP CREEK, A TRIBUTARY OF
THE COLORADO RIVER OF TEXAS,
WITH PLANNED FLOOD-WATER -
RETARDING STRUCTURES AND
OTHER WATER MANAGEMENT
MEASURES

LEGEND

-  Detention Structure
-  Earth Gully Plug
-  Drop Inlet
-  Culvert
-  Floodwater Diversion
-  Floodway
-  Drainage Area Boundary
-  Outline of Tributary
-  Damage Area
-  Watershed Boundary
-  Paved Road
-  Improved Road
-  Dirt Road
-  Railroad
-  County Line
-  Drainage
-  Lake
-  Small Community



SCALE OF MILES
0 1/2 1
APPROX. 45,800 ACRES

STANDARDS A LOCAL WATERSHED ORGANIZATION MUST MEET FOR FEDERAL ASSISTANCE

1. DEVELOP, OR AGREE ON, A PLAN FOR WORKS OF IMPROVEMENT.
2. SUBMIT AN APPLICATION WITH PROPOSED PLAN TO THE SECRETARY OF AGRICULTURE THROUGH APPROPRIATE CHANNELS.
3. PREPARE DESIGNS AND SPECIFICATIONS FOR THE NECESSARY STRUCTURAL PHASES OF THE PLAN.
4. ASSUME RESPONSIBILITY FOR CONSTRUCTION OR FOR THE ADMINISTRATION OF CONTRACTS FOR CONSTRUCTION.
5. SHARE IN THE COST OF INSTALLING WORKS OF IMPROVEMENT, WITH CERTAIN EXCEPTIONS.
6. PROVIDE EASEMENTS AND RIGHT-OF-WAYS.
7. OBTAIN REQUIRED AGREEMENTS TO CARRY OUT RECOMMENDED SOIL AND WATER CONSERVATION MEASURES.
8. PROVIDE NECESSARY WATER RIGHTS.
9. PROVIDE OPERATION AND MAINTENANCE FOR WORKS OF IMPROVEMENT.
10. EVALUATE THE EFFECTIVENESS OF THE PROGRAM IN ACCOMPLISHING WATERSHED PROTECTION OBJECTIVES.

AUTHORITY THE LOCAL SPONSORS MAY NEED TO QUALIFY FOR WATERSHED PROJECT

1. POWER TO FINANCE

- (a) FOR INITIAL EXPENSES**
- (b) FOR INSTALLATION**
- (c) FOR OPERATION AND MAINTENANCE**
- (d) TO PROVIDE FOR REPLACEMENTS**
- (e) LIMITATIONS ON TAX LEVIES**

2. POWER TO REGULATE

- (a) LAND USE REGULATIONS**
- (b) ZONING ORDINANCES**
- (c) OTHER POWERS**

SOIL SCIENCE

Unit C: Agencies Assisting in Soil and Water Conservation

Topic 5: Other Organizations Promoting Conservation of Soil and Water

Suggested Procedures and Activities: Have students obtain literature on soil and water conservation from the sources listed in this topic or from other available sources. Use the collected materials for class study and discussion.

1. State, National, and International Programs

Transparency No. 1

There are many public organizations promoting soil and water conservation. In addition to the SCS, the ASCS, the watershed districts, and over 3,000 soil and water conservation districts in the U.S., other cooperative conservation programs include irrigation districts, water conservation districts, drainage districts, and levee districts.

In addition to regulating conservation districts, many states manage state forests, conserve water, and promote conservation education in public and private education institutions. Many states pass legislation reducing waste of natural resources such as gas.

There are many agencies in the federal government assisting with soil and water conservation. The national forests are managed through the Forest Service of the U.S. Department of Agriculture. Wildlife conservation is administered by the Fish and Wildlife Service of the U.S. Department of the Interior. Irrigation and flood control are directed by the Bureau of Reclamation. The U.S. Army Corps of Engineers is responsible for flood control along major rivers. The National Park Service and the U.S. Geological Survey help preserve and investigate national resources.

The federal government assists cities in controlling pollution of streams through the Environmental Protection Agency and the Water Quality Board. Farmers and ranchers are aided in soil and water conservation by agents from the U.S. Cooperative Extension Service. Agricultural Experiment Stations are centered at land-grant universities supported by the states.

The Future Farmers of America and 4-H Clubs promote soil and water conservation in their local communities. These and other youth clubs carry out outstanding conservation projects for local, state, and national recognition.

World-wide conservation is practiced through many international agencies. Included in this group are the United Nations, Food and Agriculture Organization, and International Bank for Reconstruction and Development.

2. Private Organizations

Private organizations contribute to soil and water conservation. Some of these organizations include:

American Forestry Association
American Horticultural Society
Friends of the Earth
Soil Conservation Society of America
Resources for the Future
Sierra Club

3. Sources of Soil and Water Conservation Information

A. State Agencies (Texas)

Soil Conservation Service
U.S. Department of Agriculture
16-20 South Main Street
P.O. Box 648
Temple, Texas 76501

Texas Department of Agriculture
P.O. Box 12847
Capitol Station
Austin, Texas 78711

Texas Water Quality Board
Administrative Operations Division
P.O. Box 13246
Capitol Station
Austin, Texas 78711

B. State Agricultural Universities (Texas)

East Texas State University
Department of Agriculture
East Texas Station
Commerce, Texas 75428

Prairie View A&M University
Department of Agriculture
Prairie View, Texas 77445

Sam Houston State University
College of Applied Arts and Sciences
Huntsville, Texas 77341

Southwest Texas State University
School of Applied Arts
San Marcos, Texas 78666

Stephen F. Austin State University
College of Agriculture
Nacogdoches, Texas 75962

Tarleton State University
College of Agriculture
Stephenville, Texas 76402

Texas A&M University
Department of Soil and Crop Sciences
College Station, Texas 77843

Texas A&I University
Department of Agriculture
Kingsville, Texas 78363

Texas Technological University
College of Agriculture
Lubbock, Texas 79409

C. U.S.D. A. Agencies

Agricultural Research Service

Agricultural Stabilization and Conservation Service

Extension Service

Farmers Home Administration

Forest Service

National Agricultural Library

Soil Conservation Service

Address for the above:

U.S. Department of Agriculture
Office of Information
Washington, D.C. 20250

Environmental Protection Agency
401 M. Street, Southwest
Washington, D.C. 20460

or

Suite 1100
1600 Patterson Street
Dallas, Texas 75201

D. United States Department of the Interior Agencies

National Park Service

Office of Saline Water

U.S. Fish and Wildlife Service

Address for the above:

U.S. Department of the Interior
Washington, D.C. 20240

E. Other U.S. Government Agencies

U.S. Geological Survey
National Center
12201 Sunrise Valley Drive
Reston, Virginia 22092

The Youth Conservation Corps
P.O. Box 2975
Washington, D.C. 20013

F. International Organizations

Food and Agriculture Organization
Via delle Terme di Caracalla
00100 Rome
Italy

International Bank for Reconstruction and Development
1818 H. Street, N.W.
Washington, D.C. 20433
U.S.A.

United Nations
New York, N.Y. 10017
U.S.A.

United Nations Educational Scientific and Cultural Organization
Place de Fontenoy
Paris VIIe
France

G. Private Organizations

American Association of Nurserymen, Inc.
230 Southern Building
Washington, D.C. 20005

American Forestry Association
1319 Eighteenth Street, N.W.
Washington, D.C. 20036

American Horticultural Society
Mt. Vernon, Virginia 22121

American Society of Agronomy

and

Soil Science Society of America
677 South Segoe Road
Madison, Wisconsin 53711

The Conservation Education Association
1250 Connecticut Avenue, N.W.
Washington, D.C. 20036

The Fertilizer Institute
1015 Eighteenth Street, N.W.
Washington, D.C. 20036

Friends of the Earth
529 Commercial Street
San Francisco, California 94111

Garden Centers of America
230 Southern Building
15th and H. Streets, N.W.
Washington, D.C. 20005

National Association for Environmental Education
P.O. Box 569031
Miami, Florida 33156

National Association of Conservation Districts
1025 Vermont Avenue, N.W.
Washington, D.C. 20005

National Audubon Society
1130 Fifth Avenue
New York, New York 10028

National Limestone Institute, Inc.
1315 Sixteenth Street, N.W.
Washington, D.C. 20036

The Nature Conservancy
1800 N. Kent Street, No. 800
Arlington, Virginia 22209

Resources for the Future
1755 Massachusetts Avenue, N.W.
Washington, D.C. 20036

Sierra Club
Department MS
P.O. Box 7959
Rincon Annex
San Francisco, California 94120

Soil Conservation Society of America
7515 Northeast Ankeny Road
Ankeny, Iowa 50021

References:

1. Donahue, Roy L., Roy H. Follet, and Rodney W. Tulloch, Our Soils and Their Management, 4th. ed., The Interstate Printers and Publishers, Inc., Danville, Illinois, 1976, pp. 727-752.
2. Knuti, Leo L., Milton Korpi, and J.C. Hide, Profitable Soil Management, 2nd. ed., Prentice-Hall, Inc., Englewood Cliffs, N.J., 1970, pp. 253-256.
3. Lytle, R.A. and H.B. Kircher, Investigations in Conservation of Natural Resources - A Student Laboratory Manual, 1st. ed., The Interstate Printers and Publishers, Inc., Danville, Illinois, 1979, pp. 187-190.

OTHER ORGANIZATIONS PROMOTING SOIL AND WATER CONSERVATION

INCLUDE:

- ➡ STATE AGENCIES
- ➡ STATE AGRICULTURAL UNIVERSITIES
- ➡ YOUTH ORGANIZATIONS
- ➡ U.S.D.A. AGENCIES
- ➡ U.S. DEPARTMENT OF THE INTERIOR
AGENCIES
- ➡ INTERNATIONAL ORGANIZATIONS
- ➡ PRIVATE ORGANIZATIONS

PLANT SCIENCE

Unit A: Plant Breeding

Topic 1: Maintaining Pure Lines

Suggested Procedures and Activities: Use live specimens in class such as seed samples of corn, beans, or other grain showing the differences in size and shape of seed. Use seedlings and blooming plants of the same species to explain the effect of environmental conditions. Seed or fruit can also be used when discussing environmental conditions.

1. Pure Lines in Crop Production

Transparency No. 1

Johannsen established the theory of pure line in 1903. His experiments were based upon the selection of seed from mixed seed samples of the Princess bean. He selected the bean according to bean size. Since beans are self-pollinated, the progeny of both large and small beans were pure lines. Johannsen's weight tests proved that any variation in seed size of the large or small bean was due to environmental conditions in the beans' producing area since the inherent characteristics were pure. The transparency shows a mixed lot of Princess beans with two pure lines being selected. Pure line No. 19 was selected and grown in isolation. This random selected bean produced seed similar to the parent line, weighing 35.1 centigrams, and further selection from the large and small beans still produced seed weighing about the same, 35.8 centigrams for the small seed of this lot and 34.8 centigrams for the large seed. Pure line likewise produced seed like the parent line. The random selected large seed produced an average weight of 64.26 centigrams, and the seed, both large and small, produced 64.9 and 63.1 centigram averages. The genotype line was not changed after further selection in the two pure lines; therefore, new genotypes are not developed through pure line selection.

Before Johannsen made his work known, early agriculturalists introduced new crops by selecting seed from wild plants and transplanting wild plants in order that the crop plant or plants could be cultivated. From these cultivated plants, the farmer continued to select seed or plants that best served the needs. Seeds and seedlings were selected from plants that survived droughts, suffered less insect and disease damage and produced high quality food or feed. This method of plant improvement continued until Mendel worked out his laws of heredity in the mid-19th Century. His work went unnoticed until the 1900's.

The systematic improvement of plants through plant breeding did not become a reality until the 20th Century. Even though the Old World (China, South Asia, Central Asia, Asia Minor, Mediterranean area and Abyssinia) domesticated

approximately five-sixths of all species of cultivated plants, the New World (North America, Central America and South America) has worked extensively to improve the remaining one-sixth of the cultivated plants which were found in the New World. Since the colonists landed on Plymouth Rock, the western world has continued to introduce cultivated plants from the Old World. Pure line selection has been practiced by farmers by their observing off-type plants in their fields and selecting seed from the better plants.

A pure-line variety consists of the genetically identical progeny of a single, self-fertilized, homozygous plant. Identical genes are transmitted by such individual plants through their germ cells; thus, all the offsprings are identical to the parent plant and to each other. The progeny of pure-line varieties remains pure except for mutations or out crossings. A purebred self-pollinated plant breeds true.

2. Pure Line Selection

Many plant varieties have been produced by pure line testing and selection methods. Progeny tests follow pure line selection in order to determine whether or not the plant has the desirable characteristics for future production. In progeny testing, the individual plant's performance can be observed and studied. After a selected strain is accepted due to approved characteristics, it is named, grown in quantity, and placed on the agriculture market as a new variety.

Pure line varieties can become impure even though they were originally considered pure. The main causes of pure lines becoming impure are natural cross-pollination with other varieties, mutations, and the mechanical mixing of seed with other varieties. Emphasis has been placed upon developing varieties that are completely uniform in appearance and performance. In recent years less emphasis has been placed on complete uniformity.

The main reason for selecting plants is to preserve the desirable characteristics and eliminate the undesirable traits or characteristics. Until recently the farmer and plant breeder developed all plants along pure-line varieties. Most crops are still marketed according to appearance and other standards; therefore, it is necessary to maintain pure-line varieties in certain crops in order to produce uniformity, texture, firmness, and other grade standard qualities. In some cases multiple or mixed varieties are developed for the following reasons:

- a. To produce better yields under adverse climatic conditions.
- b. To give better protection against insects and diseases.
- c. To produce a raw material that is easily harvested.
- d. To grow plants that will produce on different types of soils.

Pure-lines are developed for the purpose of breeding true characteristics in plants. Example: F_1 hybrids are produced by using two pure-line parents. The characteristics that remained pure by continuous inbreeding are transmitted from

the parents to the offsprings by gametes (germ cells). Before crossing two pure-lines to produce an F_1 hybrid or cross, it is very important to select parent plants with desirable traits.

3. Self-Pollination

Transparency No. 2

Crops such as wheat, oats, barley, flax, rice, soybeans, peas, and beans are self-pollinated crops. They are usually easily maintained as pure varieties due to the characteristics of the plants. They remain mostly pure when grown in close proximity of closely related similar varieties. Corn, cotton, and grain sorghum must be isolated if it is to remain pure. The floral parts must be covered to protect the crop from foreign pollen; otherwise, cross-pollination may occur. A pure line of soybeans may remain pure, but a pure line of cotton can become impure due to cross-pollination from other cotton plants, even though the cotton flower is also self-pollinated. As shown in Transparency No. 2, the flowers of (1) tobacco and (4) legumes are better protected from foreign pollen than cotton (2), tomato (3), and grass (5).

With crops that are completely self-fertilized, it is not necessary to reselect for plant characteristics because selfed plants will remain pure unless mutations occur. New genotypes (heredity makeup of an individual plant, combined with the environment, controls characteristics) are not developed through pure-line selection; the genotype is already present in the plant population. Self-pollinated plants used for crossing and for pure breeding crop production are usually considered approximately 95 percent pure. Through proper management, self-pollinated plants can be kept pure for breeding purposes. The seed of a self-pollinated plant is used each year for reproduction purposes, whereas new cross-pollinated hybrid seed must be used each year.

Selfed (self-pollinated) refers to a plant where the pistil part of the flower is fertilized with pollen from the same plant that bears the pistil. Inbreeding plants is usually accomplished by self-pollination. This type of plant breeding improves the homogeneity. The number of heterozygous genes are reduced in selfing.

Cotton, sorghums, and sudangrass are crops that vary in methods of field crop pollination. The species in this group of plants have perfect flowers, and the receptive stigma may be exposed to cross- and self-pollination. Wind causes cross-pollination in sorghum, and insects cause cross-pollination in cotton.

Transparency No. 3

Many legume plants (1) such as clovers, beans, and peas breed true because the stigma and other floral parts are protected from foreign pollen by the petals and sepals. Some plant flowers are only partially protected from foreign pollen,

as in the case of tobacco (2). If the flower is to be 100 percent self-pollinated, the floral parts must be covered with a bag. Corn can be selfed (self-pollinated) because the male part (tassel) and female part (silk) are on the same plant. The only safe way to self-fertilize or self-pollinate corn is to protect the female part. Self-pollinating steps used on corn are:

- a. Cover the ear shoot with a glassine bag before the silks appear to protect them from pollen (a).
- b. Two days before pollination two or three inches of the tip of the ear shoot is removed and it is bagged again.
- c. The day before the plant is to be pollinated a paper bag is placed over the tassel (b).
- d. The bag is removed from the ear shoot. Pollen is collected into the tassel bag and then dusted on the silk brush (c).
- e. The tassel bag is tied over the ear shoot (d) to protect it from foreign pollen.

4. Reduction in Vigor by Self-Pollination

Many crop plants that are normally cross-pollinated can be self-pollinated artificially, in order to develop pure lines. Continuous inbreeding of cross-fertilized crops will eventually cause a loss of plant vigor in some of the plant traits or characteristics. The abnormalities that may appear are:

- a. Lodging (bending or breaking over) in grains
- b. Lack of chlorophyll development
- c. Low production
- d. Sterility
- e. Dwarfness
- f. Susceptibility to diseases
- g. Lethal seeding

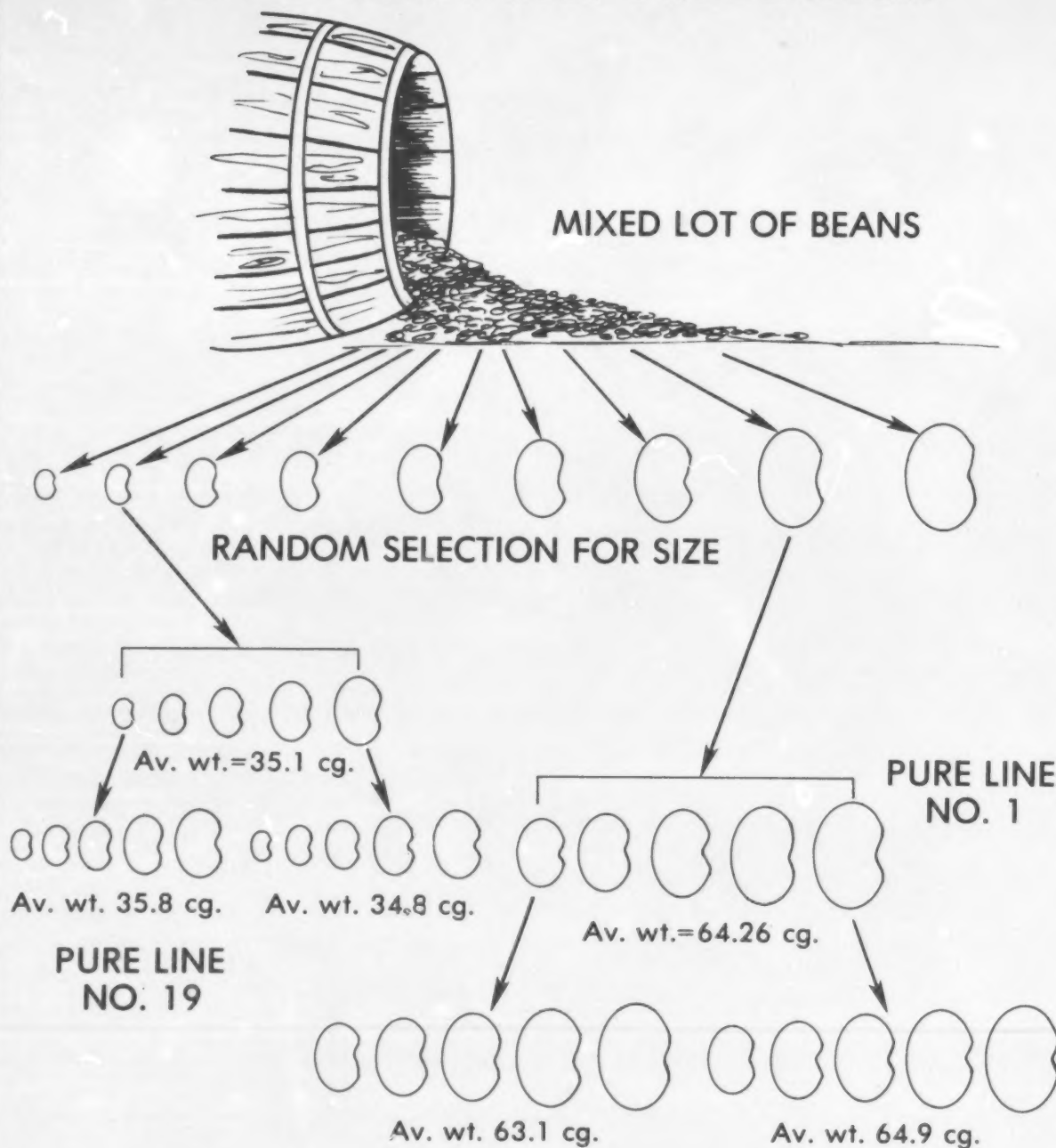
Transparency No. 4

Plant vitality begins to decrease in onions after they have been inbred for about three years. Cotton seems to lose plant vigor after about four years of inbreeding and corn may begin to lose some of its vigor when inbred more than five or six years. The sorghum crops seem to maintain plant vigor even after as much as twelve years of inbreeding. Inbreeding may cause the recessive characteristics to come forward. This may be desirable in some plants.

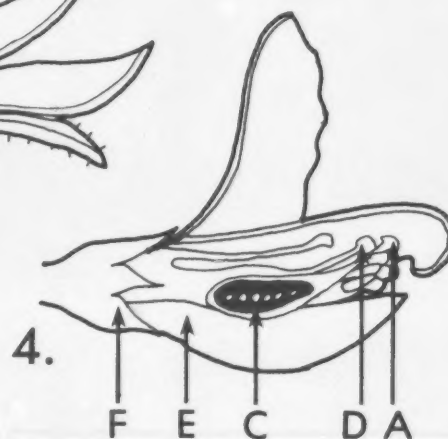
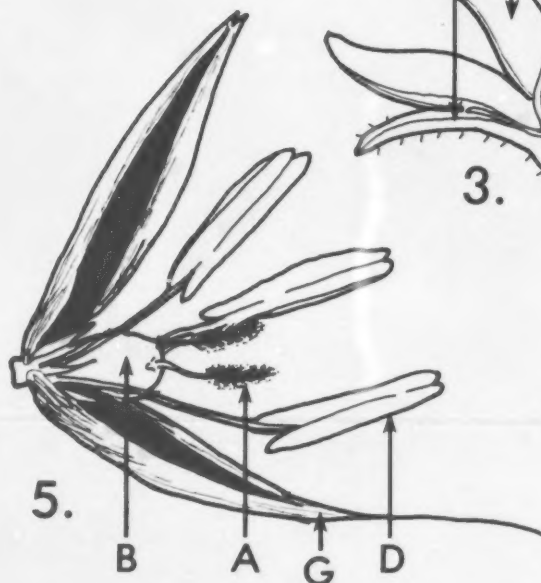
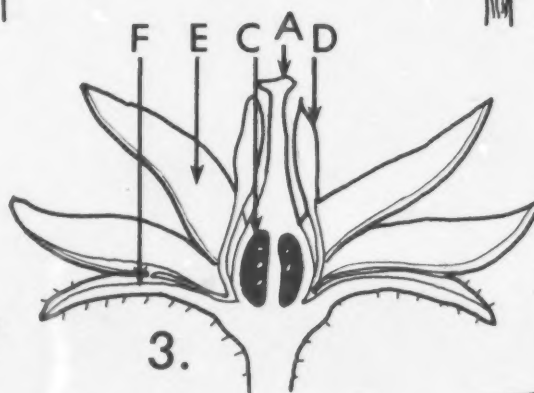
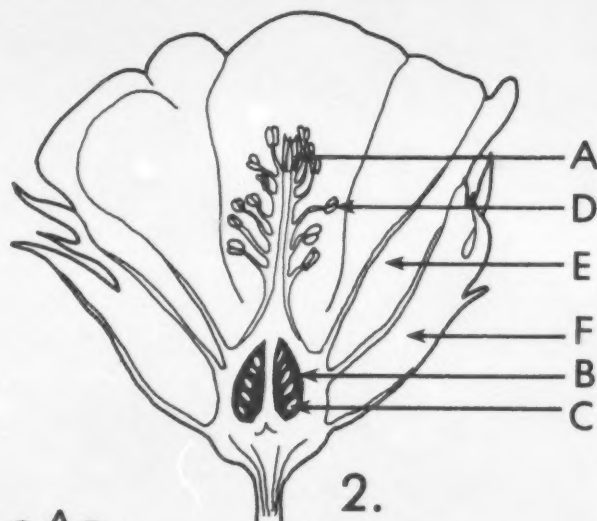
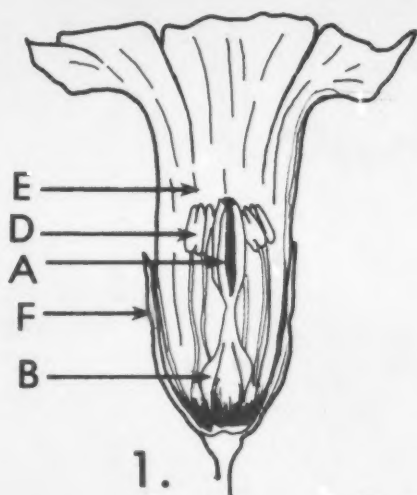
References:

1. Delorit, Richard J. and Others, Crop Production, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1974.
2. Janick, Jules and Others, Plant Science an Introduction to World Crops, W. H. Freeman and Company, San Francisco, California, 1974.
3. Poehlman, John Milton, Breeding Field Crops, Holt, Rinehart and Winston, Inc., New York, New York, 1959.

PURE LINES IN CROP PRODUCTION



TYPES OF FLOWERS SELF POLLINATED NATURALLY

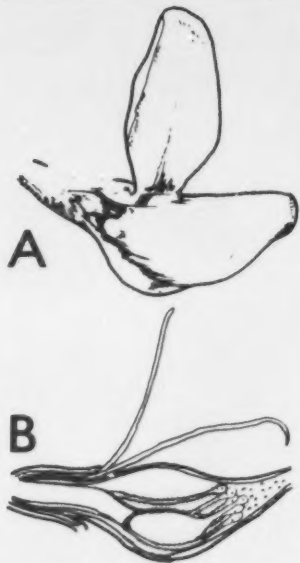


A - STIGMA
B - OVARY
C - OVULE

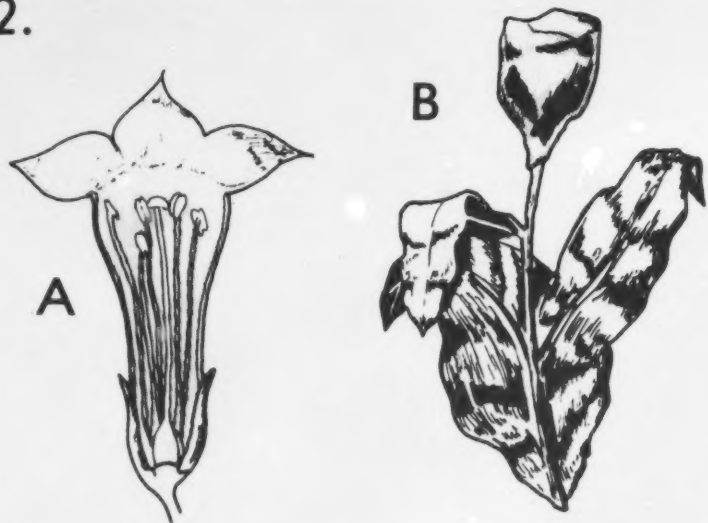
D - ANTHOR
E - PETAL
F - SEPAL

SELF POLLINATING PLANTS

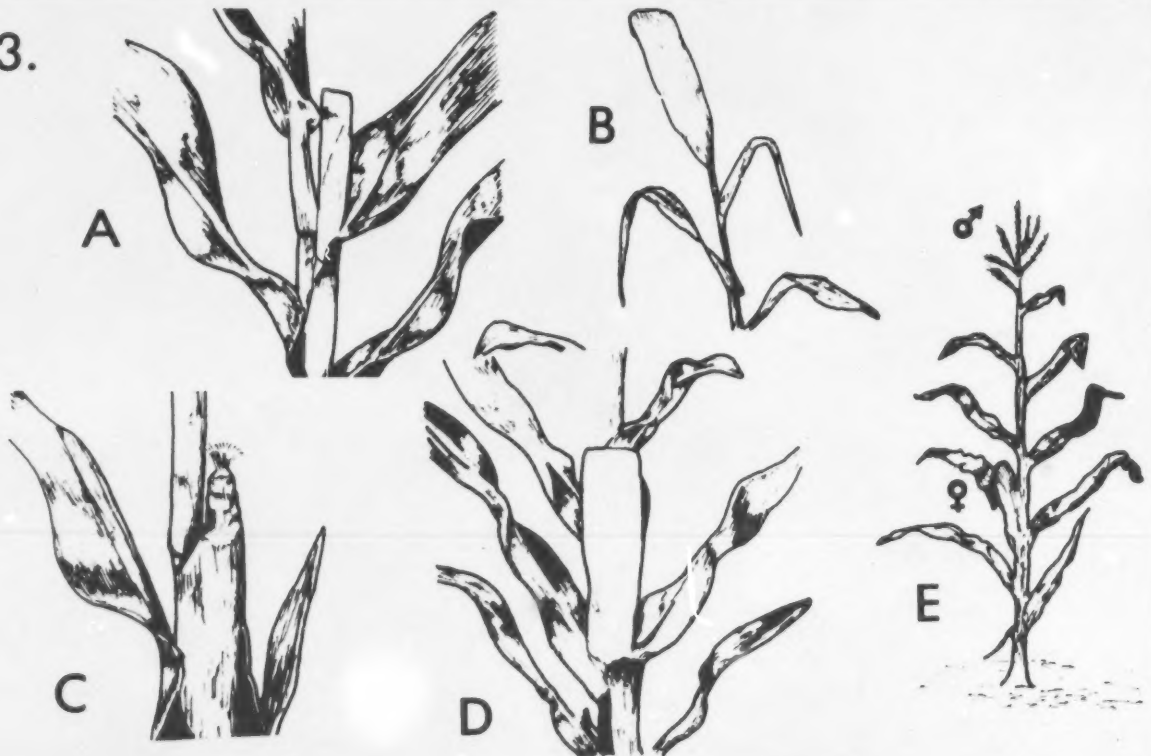
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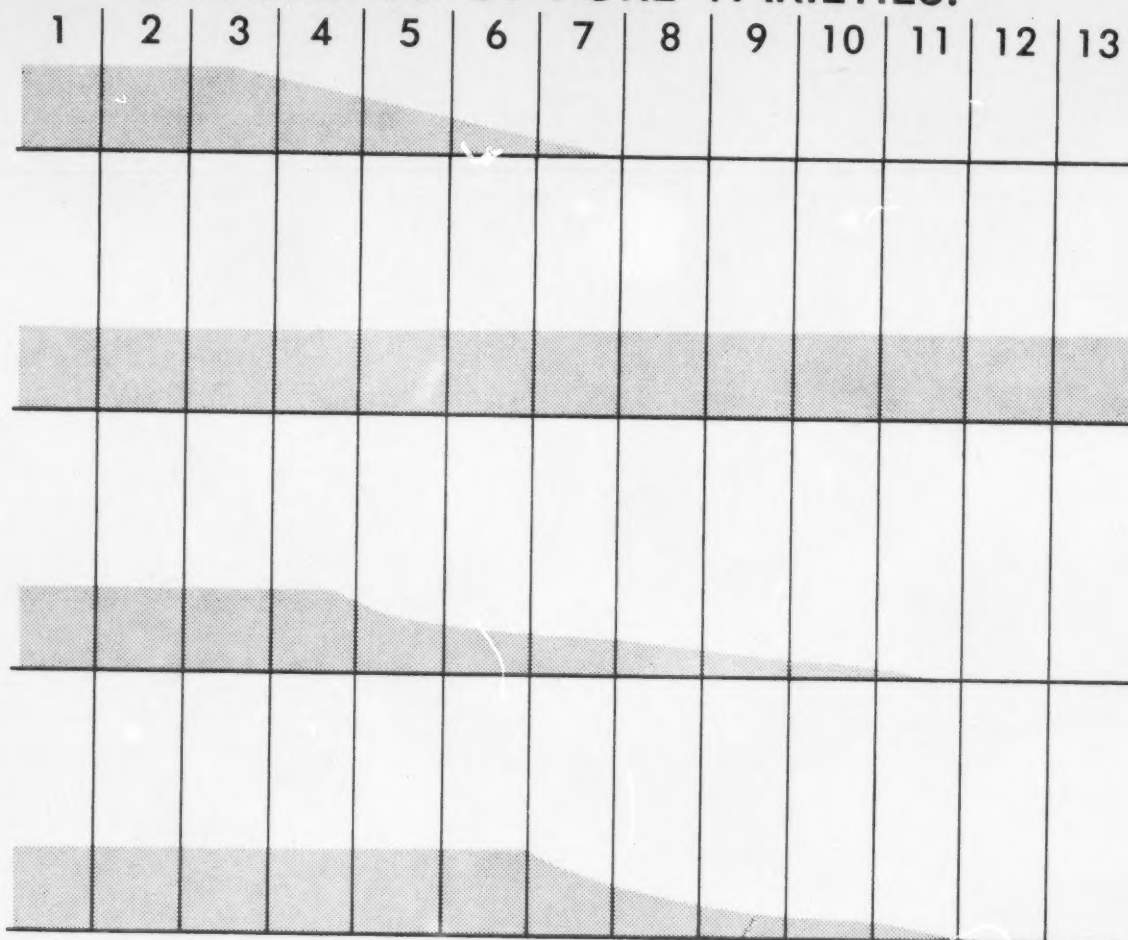
2.



3.



VITALITY IS LOST IN SOME CROPS DUE TO REPEATED INBREEDING OF PURE VARIETIES.



PLANT SCIENCE

Unit A: Plant Breeding

Topic 2: Hybridization

Suggested Procedures and Activities: Charts may be used with transparencies to point out the different types of hybrids.

1. Early Improvement of Crop Plants

Animal life would cease to exist on earth if plant life was suddenly destroyed. The proper management of crop plants is the basis for human sustenance. All food comes from plants, either directly or indirectly. Cultivation of crop plants dates back to the Neolithic age. The introduction of new plants began in the New World during the Sixteenth Century. Plant taxonomy was on its way to maturity in the Eighteenth Century. Also, the studies in plant physiology were initiated in the Eighteenth Century.

Before the Sixteenth Century, crossbreeding, inbreeding, and selection of plants were done by nature; the only plants that survived were those that could withstand the hazards of the environment. Man took many years to discover that certain plants were useful to him and by gathering the best seeds for planting, he could better feed and clothe his family. Crude as it was, this was the beginning of plant improvement; however, little progress was made until Gregor Mendel, the Austrian monk, discovered the laws of heredity. Mendel was one of the earliest recognized hybridizers. His experimental findings on breeding garden peas were published in 1866. In 1900, Mendel's report was of value in developing a branch of science known as genetics. The report on his experiments was instrumental in establishing a few principles of inheritance that are used in modern-day plant breeding techniques. As a result of discovering Mendel's work on plant breeding, experiments were started in 1904, by inbreeding strains of corn. When single inbred lines of corn were crossed, they produced a more productive and vigorous plant than the parent plants. This single cross was known as hybrid corn.

2. The Meaning and Reason for Hybridization

Hybridization is the crossing of plants of unlike genetic makeup. It is also a method of breeding new plant varieties that requires crossing to obtain the best qualities of the parent plant characteristics in a single strain of plants.

The reasons for hybridization are:

One of the main reasons for hybridization is to get hybrid vigor or heterosis. The hybrid has more vigor than the parent plant. Crossbreeding usually strengthens plant characteristics. Some desirable qualities can only be

developed by crossbreeding or hybridization.

Hybridization may increase yields and improve the quality of produce harvested from a crop by combining the characteristics of two plants.

Disease and insect resistant plants may be obtained from this process of plant breeding.

Another reason for hybridization is to develop plants for better climate adaptation.

It is used to combine all the desirable characteristics in crop plants. For example, if variety A corn is crossed with variety B corn, the plant breeder would look for the following:

Variety A	+	Variety B
Excellent quality grain		Fair quality grain
Weak stalk		Strong stalk
Resistant to smut		Susceptible to smut
Resistant to drouth		Susceptible to drouth

Results
 Excellent quality grain
 Strong stalk
 Resistant to smut
 Resistant to drouth

When variety C is crossed with D, the desirable qualities or results should be:

Variety C	+	Variety D
Fair quality grain		Good quality grain
Strong stalk		Weak stalk
Susceptible to smut		Resistant to smut
Resistant to drouth		Susceptible to drouth

Results
 Good quality grain
 Strong stalk
 Resistant to smut
 Resistant to drouth

As stated previously, corn carries 20 chromosomes; 10 are male and 10 are female. If ABCDE carry the characteristic for good yields, and inbred A genotype AABBBccddEE with ABE being dominant plus inbred B genotype aabbCCDDEE with CDE being dominant, then the genotype F_1 hybrid would be AaBbCcDdEE. In that the F_1 hybrid has dominant genes ABCDE represented, it becomes more vigorous than either of the parent inbred lines.

3. The Plant Cell Structure

Transparency No. 1

The entire structural unit of a plant consists of cells. They are of many types and have many functions. The plant characteristics are determined by what happens when the male cells unite with the female cells. The term is known as fertilization. Through hybridization there may be a change in the food making, support, food conducting, absorption, and food storage cells. In most plants the cells are very small and can only be seen after they are magnified. However, some cells such as green algae may exceed an inch in length. The smallest forms of plant cells are bacteria. The entire cell structure may be divided into three groups: the cell wall, protoplasts (living parts of the cell), and orgastic substances (nonliving components of protoplast).

- a. Cell Wall - The cell wall encloses the living substance of a cell. They are semirigid structures that may take on an ovoid, spherical, cylindrical, or elongated shape.
- b. Protoplast - Protoplast is the living parts of a cell grouped in a single unit. The term protoplasm refers to all living matter of a cell that makes up the protoplast. Protoplasm consists mainly of plastids (the cytoplasm colorless materials that aid in making and storing plant food), nucleus, and vacuoles. However, the chloroplasts are special plastids filled with chlorophyll (green pigment) and they may contain starch and oil. The nucleus contains the nucleolus (photoplasmic body) and chromatin (hereditary material). Vacuoles are plant cell cavities that may contain sugars, acids, and colors. Another part of the plant cell is the plasma membrane which is a two-layer membrane on the outer surface of the protoplast.
- c. Orgastic Substances - These substances are components of the protoplast which are nonliving. They are in the cell sap of vacuoles. The crystals are made up mainly of calcium oxalate. The dissolved substances are sugars and salts.

4. How the Plant Acquires Certain Characteristics

Transparency No. 2

Plant characteristics are determined by what happens when the male and female

cells unite at the time of fertilization. Each plant has a certain number of chromosomes which are contained in the nucleus. These chromosomes are rod-like bodies that carry genes arranged in linear order.

The same number of chromosomes are found in the male and female cells (gametes). Chromosome pairs are formed when the male and female chromosomes unite. For example, corn carries 20 chromosomes; 10 are male and 10 are female. At the time of fertilization 10 pairs are formed. If the genes are identically paired (dominant and recessive) on the chromosome pair, the traits of the plant will be true breeding or homozygous. If the chromosome carries both dominant and recessive or dissimilar genes for the same traits or characteristics, then the plant will not be true breeding for those specific traits and is considered to be heterozygous.

The characteristics supplied by the genes (a unit causing inheritance characteristics located on the chromosome) determines what the plant will be like. The dominant and recessive traits are identified as follows by large and small letters:

E
S
w

e
S
w

Ee
SS
ww

Male Chromosome
with two dominant
and one recessive
gene

Female Chromosome
with one dominant and
two recessive genes

Male and female
Chromosomes
united with two
complete dominant
and two recessive
genes

The superior or dominant genes will usually appear as a plant characteristic whereas inferior or recessive genes will not usually appear as a plant characteristic, if the dominant gene is present. Example: If "E" represents excellent quality grain and a dominant characteristic in one plant and "e" represents fair quality grain and a recessive characteristic, and the two plants are crossed, the "Ee" first offspring will have excellent grain.

Sometimes the gene is neither dominant nor recessive; therefore, when they occur in the same plant an intermediate characteristic is formed. Example: If we assume that variety A and B in Transparency No. 1 are crossed and the gene characteristics are incomplete dominance, then "Ee" is neither excellent nor fair quality grain, but it is a blending of the two, which is good quality grain.

Transparency No. 3

Mendel's experiments with the garden pea proved that the F₁ hybrid (first filial

generation) carried the dominant gene "T" that caused all the plants to be of the same genotype (Tt). Mendel used one parent generation (P₁) that was pure for tallness, and all the F₁ generation was tall. The first generation of inbreeding of the F₁ generation (Tt) from controlled self-pollination is designated as S₁, the second S₂. The S₁ corresponds to F₂ controlled hybridization. In the S₁ generation 75 percent of the plants were tall and 25 percent were dwarf. The ratio of tall plants to dwarf plants were 3:1. In the S₂ generation all the progeny of tall plants was tall and the dwarf plants dwarf. The phenotype (external appearance) of Mendel's peas was not always the same as the genotype (genetic constitution).

Transparency No. 4

The parents of the F₁ plants are homozygous (AAbb and aaBB), that is, the gametes of any one parent have identical gene alleles. These genes combine to produce F₁ or heterozygous (AaBb) plants, which in the case of wheat, is excellent grain and resistant to lodging because A and B are complete dominant characteristics. The egg and sperm (gametes) of the F₁ have four combinations of genes (AB, aB, Ab, and ab). When the four kinds of eggs are united with the four kinds of sperms, the combination of the genes will result in an F₂ phenotype with sixteen possible combinations. However, there are only nine genotypes and four phenotypes in this double cross. These types of combinations are:

Genotypes	Phenotypes
1/16 AABB]	9/16 Excellent grain and resistant to lodging
2/16 AABb]	
2/16 AaBB]	
4/16 AaBb]	
1/16 AAbb]	3/16 Excellent grain and susceptible to lodging
2/16 Aabb]	
1/16 aaBB]	3/16 Fair grain and resistant to lodging
2/16 aaBb]	
1/16 aabb]	1/16 Fair grain and susceptible to lodging

The combination is also listed as follows:

AABB	AABb	AaBB	AaBb
AABb		AaBb	
AaBB	AaBb	(9-excellent grain and resistant to lodging)	
	AAbb		Aabb
		(3-excellent grain and susceptible to lodging)	
		aaBB	aaBb
		aaBb	
		(3-fair grain and resistant to lodging)	
			aabb
		(1-fair grain and susceptible to lodging)	

The dihybrid cross (two traits) gives a 9:3:3:1 ratio in the F_2 generation. The most desirable combination of genes produces a plant with excellent grain and resistant to lodging (AABB). The least desirable gene combination produces plants with fair grain and susceptible to lodging (aabb). These two combinations are considered to be homogenous, and will continue to reproduce like plants if self-pollinated.

5. Nuclear Division Occurring in the Cell

Transparency No. 5

The two types of nuclear division occurring in the cell are:

Mitosis - In this process of cell division each chromosome splits longitudinally and forms two chromatids. The chromatids migrate in equal numbers to each of the poles. Two daughter cells or nuclei are formed that are similar to the parent cells and they are separated by a partitioning cell wall. This is the only form of cell division associated with asexual reproduction.

Meiosis - This second form of nuclear cell division is associated with sexual reproduction. Several cell divisions take place in the formation of gametes. The cell divides twice and the chromosome once. Meiosis

takes place on the division of the spore mother cells which divide to form the spores. The first division is reductional and the second equational. The process is as follows:

Each chromosome is duplicated lengthwise to form two chromatids. Those that contain genes with similar hereditary characteristics are paired (homologous chromosomes). The chromosomes with their chromatids joined together move to the equator of the spindle. The homologous chromosomes separate and a member of each pair moves to the poles. The four pairs of chromatids move to opposite poles; they divide the second time moving to opposite poles before the four daughter cells are formed, each with half the number of chromosomes as the parent cell. Meiosis maintains a stable number of chromosomes in a species. This prevents the number from doubling with each generation when the two gametes fuse. Chromosome number is reduced from the diploid ($2n$) in the mother cell to haploid (n) number in spores. When the sperm and egg fuse at the time of fertilization, the zygote has restored in it the diploid chromosome number. The triple fusion of polar nuclei and sperm forms the endosperm nucleus which has a triploid ($3n$) chromosome number.

6. Producing a Hybrid Crop

Hybrid corn seed was produced in quantity in Iowa in 1926. On a test and experimental basis, the first hybrid corn was produced in 1907. Several homozygous parent (P_1) lines were produced by self-pollination of plants. These lines were crossed with two different (P_1) lines to produce an F_1 hybrid generation. By 1933 only about one percent of the farmers in the corn belt were using hybrid seed. But, in 1955 almost 100 percent used hybrid seed corn. Within five years after hybrid grain sorghum seed became available, about seventy percent of all growers were using hybrid seed.

Hybrid seed is more difficult to produce than inbred (self-pollinated) or ordinary seed. Hybrid corn seed is one of the easiest hybrids to produce due to the male and female flowers being located on the same plant. However, the development of pure lines in corn has been more difficult than many other plants because of cross-pollination. It usually takes about five years to self-pollinate an inbred line of corn which can be used for crossbreeding.

Steps involved in producing hybrid seed corn are as follows:

Transparencies Nos. 6 and 7

Select suitable strains of open pollinated varieties (two inbred lines with

desirable characteristics) that have been inbred until they are determined to be genetically pure. Self pollination in corn is the result of the silks of a plant being pollinated by the pollen from the tassel of the same plant.

An inbred line is selected as a female or seed parent and the other as the male or pollen parent. In Transparency No. 6 inbred plant A is crossed with inbred B to give a single cross. Inbred plant C is crossed with inbred plant D. A and B plants must be planted in a different field from the one C and D plants are in.

The single cross plants B and A are crossed with the single crossed plants C and D. The results of the second cross is $(B \times A) \times (C \times D)$ or a double-cross. Most hybrid corn seed is produced from the double-cross.

The three-way hybrid is produced by crossing a single inbred cross $(A \times B)$ with an inbred plant (C). The hybrid will bear characteristics of plants A, B, and C. Three-way cross has been almost entirely replaced by the double-cross. When hybrids are crossed with either parent plant, the progeny is called a backcross.

7. Techniques Used to Produce Hybrids

- a. Crossing self-fertilized wheat, garden beans, soybeans, etc. requires a different technique from cross pollinating corn, because the male and female parts are completely separated on the corn plant.

Transparency No. 8

Anthers may be removed on some self-fertilized plants by use of a needle, air or tweezers before they shed pollen. Hot water has been used to kill pollen on rice and grain sorghum in order to prevent self-fertilization. After emasculation of the flowers they are covered with bags to protect them against foreign pollen that may be transferred by insects or wind. Within a couple of days after emasculation, a sticky substance covers the stigma and pollen from the male parent (another plant) should be brushed or dusted on the stigma of the female plant. Plants that are produced from the cross-fertilized flowers are known as the F_1 cross or first filial generation. Usually only the dominant characteristics are produced in the F_1 generation. In the F_2 generation both dominant and recessive characteristics are expressed.

Transparency No. 9

- b. F_1 generation of hybrid corn is produced by planting two rows of one inbred line beside one row of another inbred line. The two rows are de-

tasseled and the one row retains its tassel for fertilization. Double or four-way hybrid is produced by planting six rows of one single hybrid and two rows of another single hybrid. The six rows are detasseled and are fertilized by the pollen from the tasseled two rows. In both single and double hybrid methods the detasseled corn is harvested for seed.

- c. Plant breeders have developed special strains of male sterile inbred lines in sugar beets, barley, corn, sorghum and other crops. Male sterile plants produce no functional pollen, that is, the male flower does not develop normally or aborts; therefore, producing no live pollen.

Male sterile lines in onions, sugar beets, sorghum and corn have all but eliminated the emasculation process in making crosses. Hybrid seed and plants are produced by planting a certain number of rows of completely fertile plants and an adequate number of rows of sterile plants.

Male sterility is either a genetic or cytoplasmic characteristic. In some crops, gene action controls male sterility whereas in others it is controlled by sterile cytoplasm in the cell. Some strains of corn do not produce pollen because of inhibiting factors in the cytoplasm (the contents of a cell outside the nucleus).

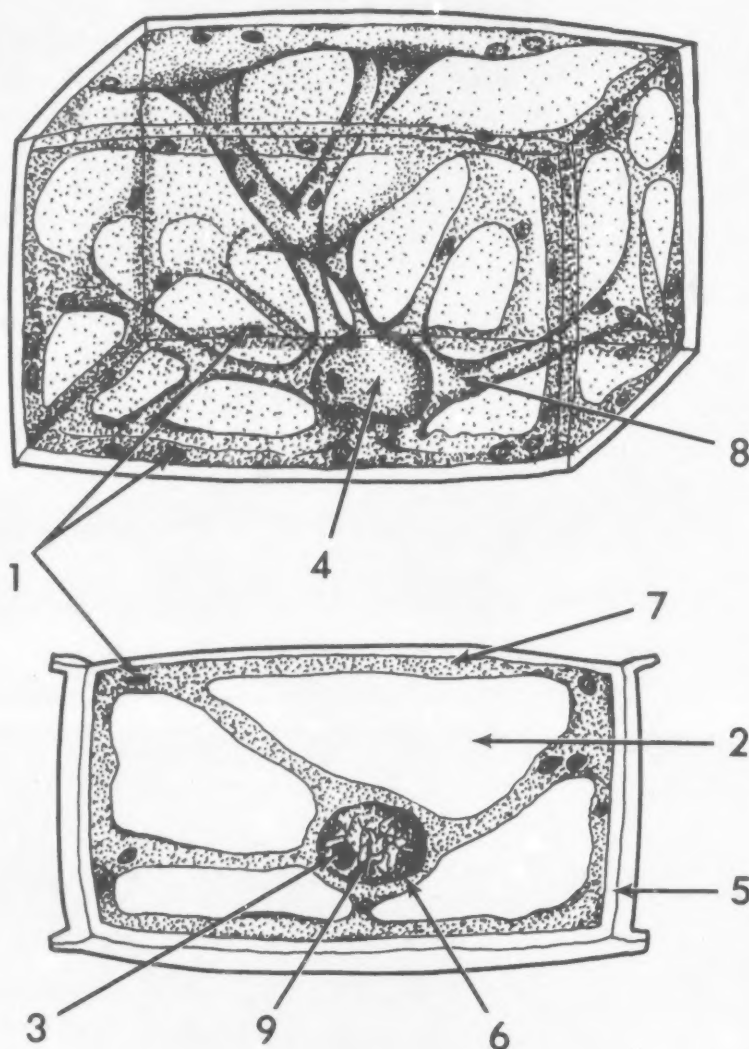
8. A List of Several Hybrid Crops

- | | |
|----------------|---------------|
| a. Cotton | l. Cabbage |
| b. Corn | m. Onions |
| c. Sorghum | n. Cantaloupe |
| d. Rice | o. Castorbean |
| e. Alfalfa | p. Millet |
| f. Soybeans | q. Spinach |
| g. Barley | r. Squash |
| h. Wheat | s. Watermelon |
| i. Oats | t. Tomato |
| j. Sugar beets | u. Eggplant |
| k. Flax | v. Sweet corn |

References:

1. Greulach, Victor A. and J. Edison Adams, Plants an Introduction to Modern Botany, John Wiley and Sons, Inc., New York, New York, 1976.
2. Heath, Maurice H. and Others, Forages, The Science of Grassland Agriculture, The Iowa State University Press, Ames, Iowa, 1976.
3. Janick, Jules and Others, Plant Science, An Introduction to World Crops, W. H. Freeman and Company, San Francisco, California, 1974.

GREEN PLANT CELL PARTS



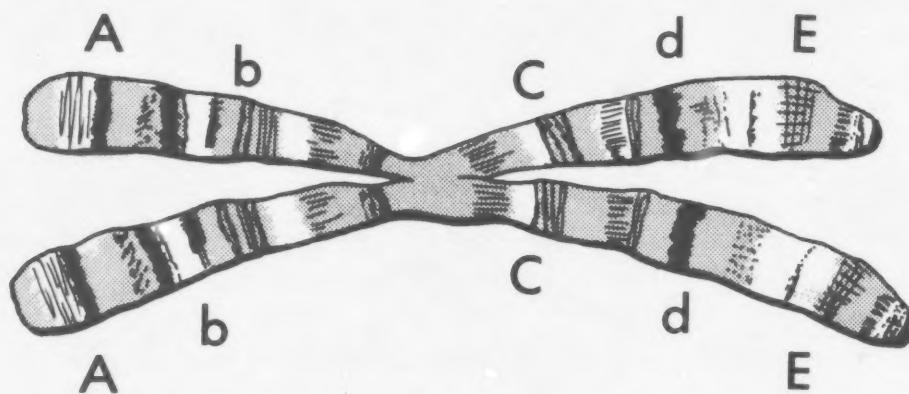
- 1. CHLOROPLASTS
- 2. VACUOLE
- 3. NUCLEOLUS
- 4. NUCLEUS

- 5. CELL WALL
- 6. NUCLEAR MEMBRANE
- 7. PLASMA MEMBRANE
- 8. CYTOPLASM

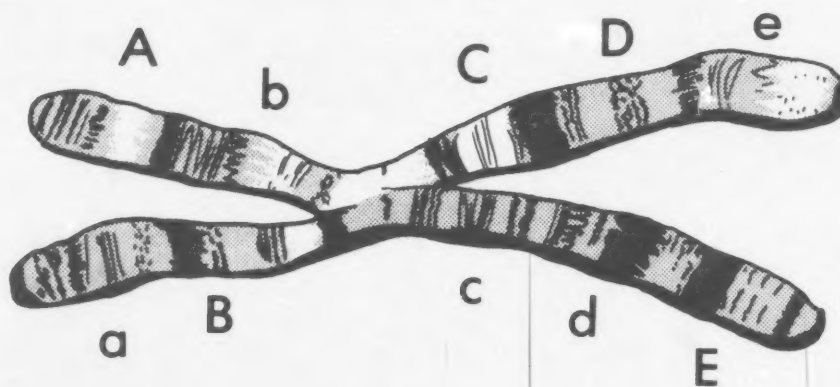
- 9. CHROMATIN

PAIRED CHROMOSOMES SHOWING GENE ALLELE COMBINATIONS

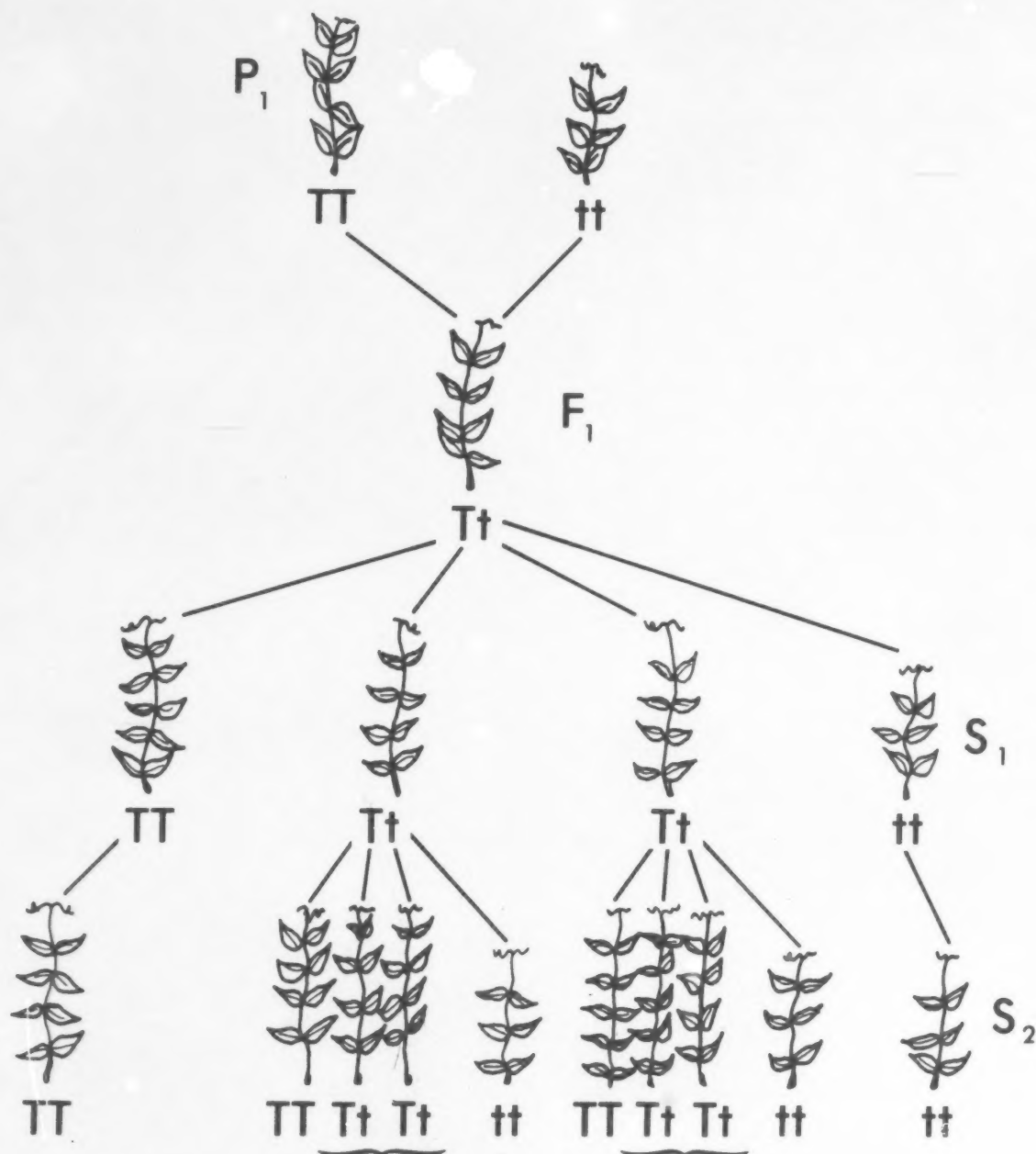
HOMOZYGOUS



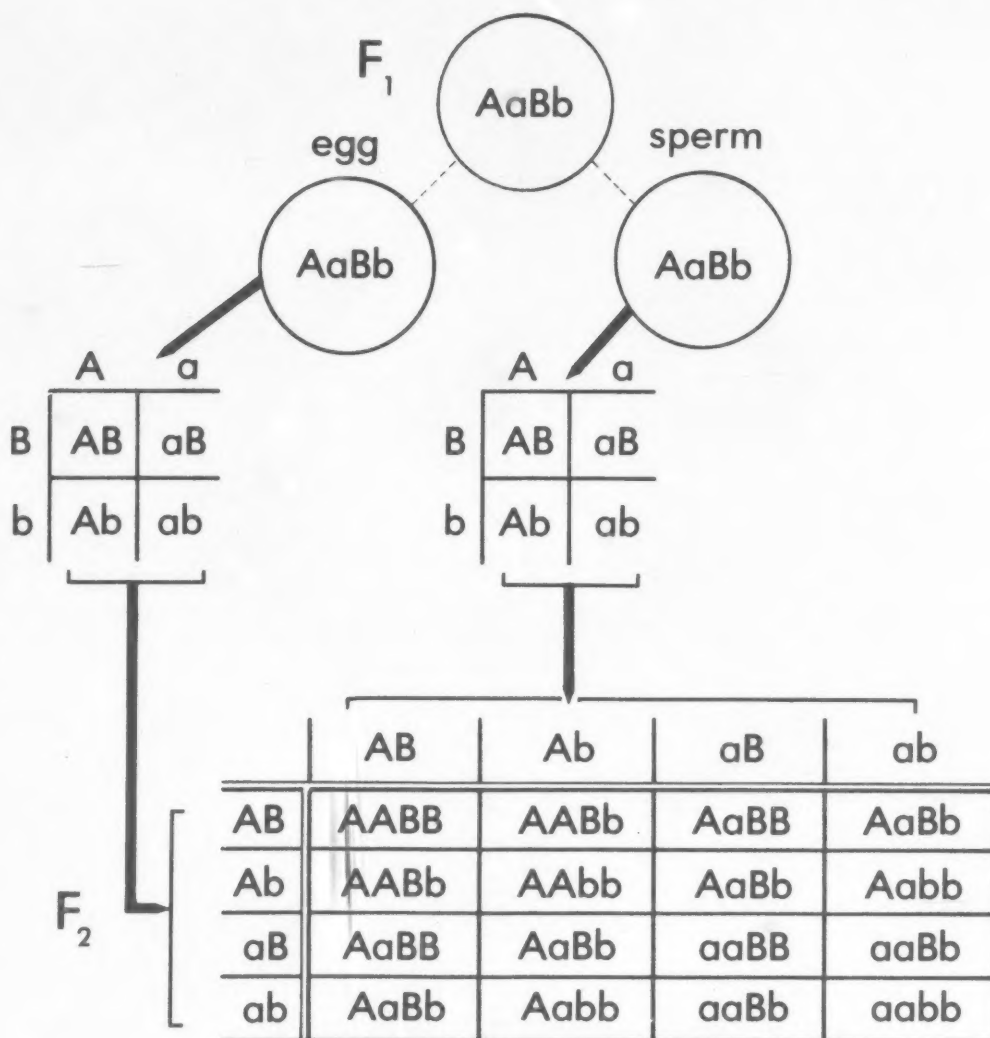
HETEROZYGOUS



MENDEL'S MONOHYBRID CROSS RATIOS:

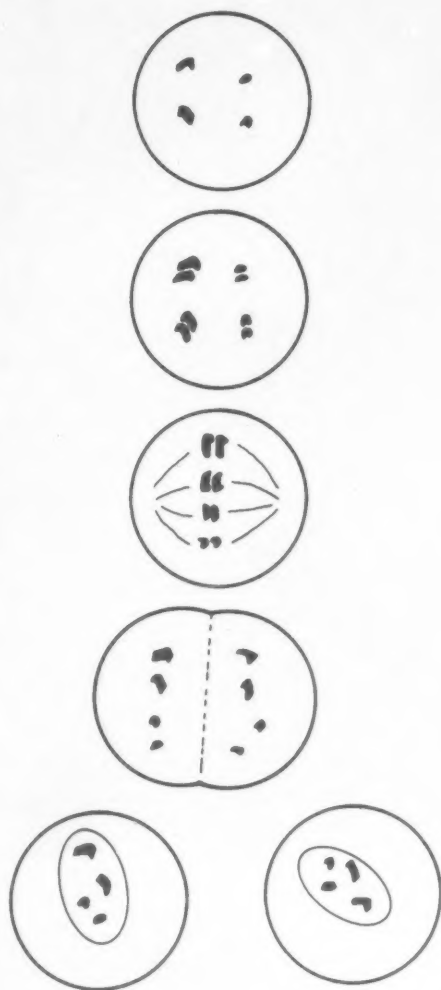


SIMPLIFICATION OF GENE PAIRING IN A DOUBLE CROSS (WHEAT)



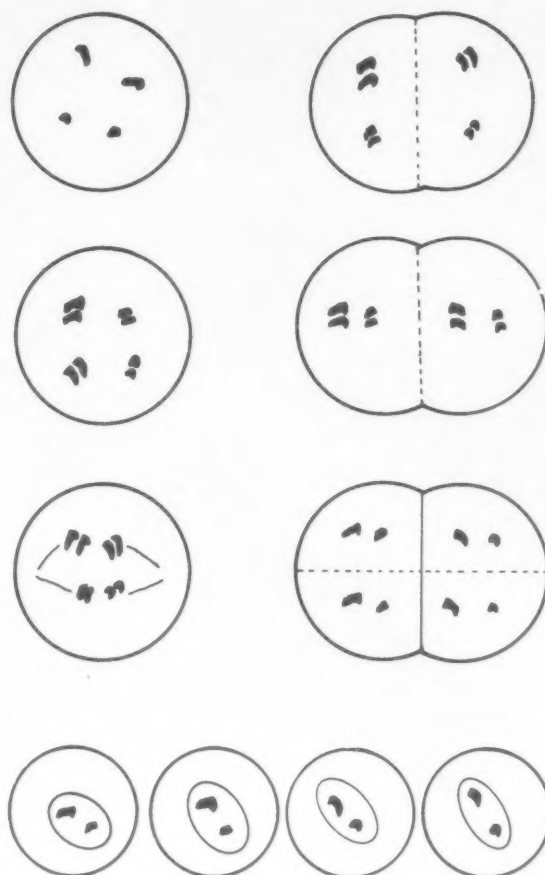
A—EXCELLENT GRAIN, DOMINANT
a—FAIR GRAIN, RECESSIVE
B—RESISTANT TO LODGING, DOMINANT
b—SUSCEPTIBLE TO LODGING, RECESSIVE

MITOSIS



MITOSIS IS THE GROWTH THAT HAPPENS IN ALL OF THE CELLS.

MEIOSIS



MEIOSIS OCCURS ONLY IN THE CELLS THAT BECOME EGGS OR SPERM.

HYBRIDIZATION

SINGLE HYBRID

A inbred x B inbred



AB

THREE WAY HYBRID

A inbred x B inbred



AB x C inbred



ABC

DOUBLE OR FOUR-WAY HYBRID

A inbred x B inbred

C inbred x D inbred

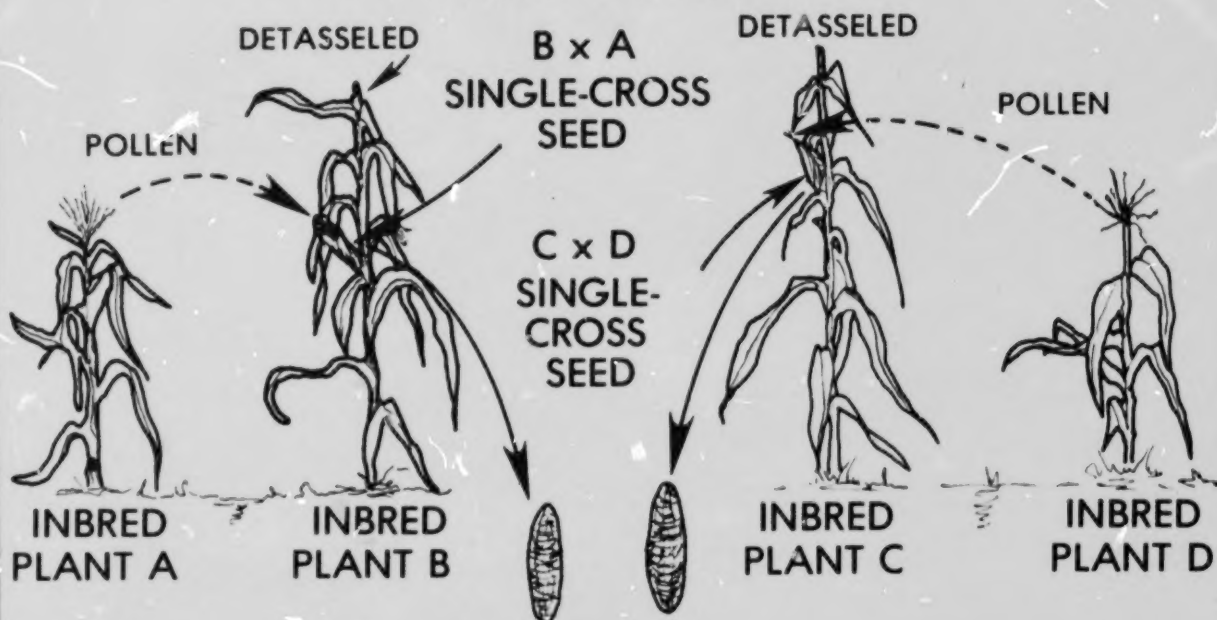


AB x CD

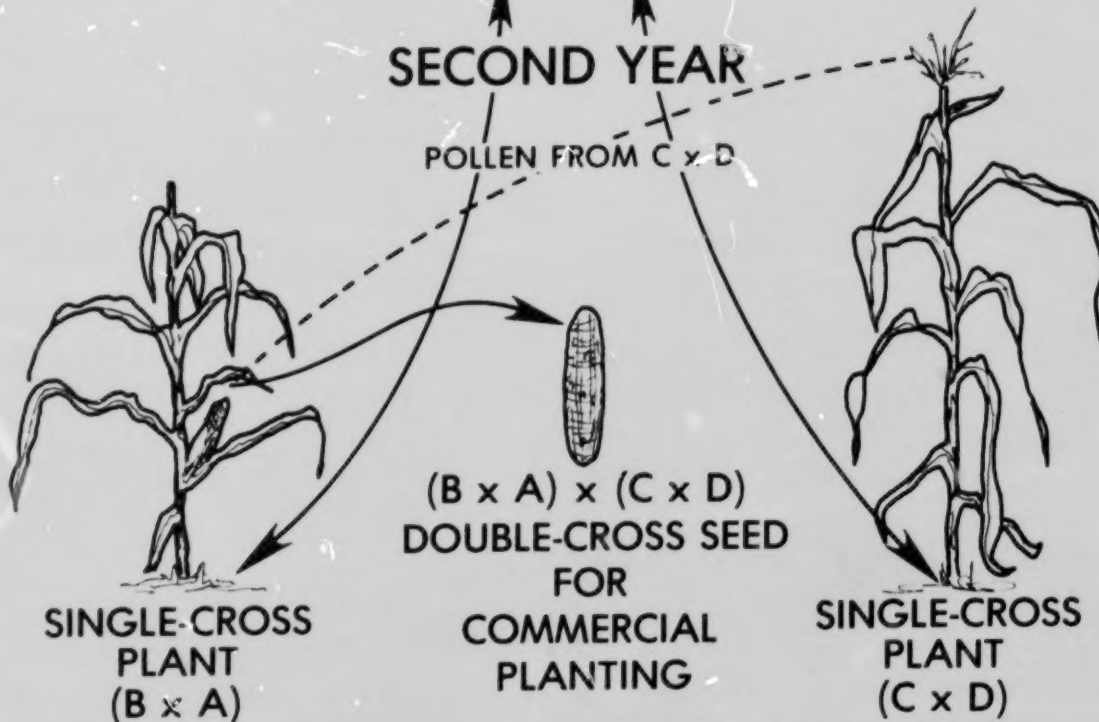


ABCD

FIRST YEAR



SECOND YEAR



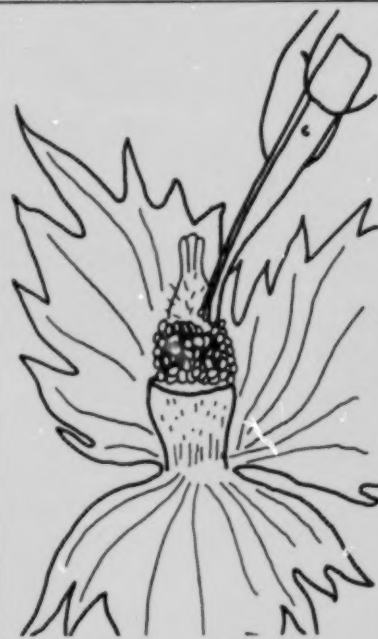
PLANT BREEDING TECHNIQUE



FLOWER READY TO CROSS



1. REMOVE SEPALS AND PETALS



2. REMOVE STAMENS OF ♀



3. COLLECT ANTHERS FROM ♂

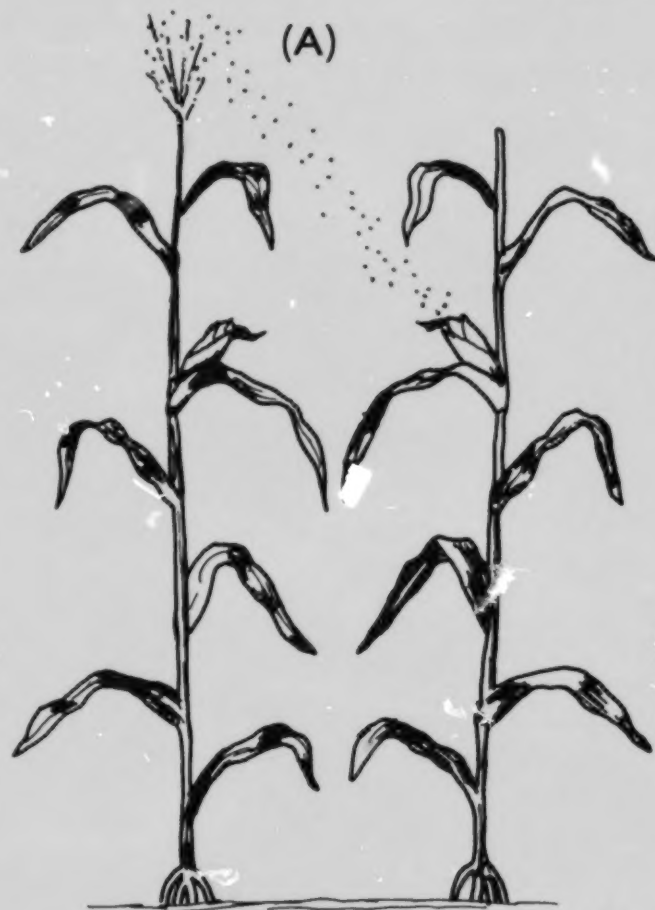


4. POLLINATE STIGMA OF ♀



5. RECORD AND PROTECT CROSS

CROSS POLLINATION



INBRED
"MALE"

INBRED DETASSELED
"FEMALE"



INBRED RESTORER
"MALE"

INBRED STERILE
"FEMALE"

PLANT SCIENCE

Unit B: Harvesting

Topic 1: Harvesting Methods and Equipment

Suggested Procedures and Activities: Most implement companies have films on harvesting equipment which are available for schools to use. Such films may be used after discussing the lesson.

1. Early Harvesting Methods

Transparencies Nos. 1 and 2

Up to the middle 1800's there was little mechanization used in harvesting crops. The sickle was one of the first pieces of harvest equipment used. It dates back to at least the year 3000 B.C. One of the greatest advances of harvesting equipment in the 1700's was the scythe and cradle. The first and greatest invention in harvesting equipment in the United States was the reaper in about 1830. About 20,000 reapers were sold in 1860. Threshers followed the reapers. Like the newly invented hay baler, they were stationary.

Prior to 1860, approximately three quarters of the population lived on farms. Hand harvesting was practiced as a part of crop production as late as 1930. Binders, mowers and combines replaced the cradle, hand sickle and knife for harvesting small grain. The fork and hoe were replaced by the mechanical potato digger. Cotton strippers and mechanical cotton pickers eliminated hand pulling and picking. The modern combines, balers, cotton pickers, forage harvesters, vegetable harvesters and fruit harvesters are mobile and have eliminated the use of stationary harvesting equipment.

The harvesting of grains and most forage crops was considered a very large task or undertaking up until 1930. Before this time the following procedure was used:

The grain was cut by a horse drawn mower.

The grain stalk (with seed) was raked into rows by a horse drawn rake.

A sweep rake (horse drawn) hauled the seed-carrying stalk to the thresher. The entire stalk was fed into the thresher by hand.

These same three steps were used when making hay.

Early hay balers and forage harvesters were stationary harvesting equipment. The crop had to be transported to the machine for completion of the harvesting process.

Harvesting of crops was considered one of the hardest kinds of farm hand-labor until mechanized harvesting equipment replaced hand labor and horse drawn equipment. For example, two men could cut and bind 2 1/2 acres of small grain per day with a cradle. When horse drawn binder was used, 10 acres of small grain could be cut and bound each day. Large mobile type combines which are in common use today can harvest many acres per day, depending upon the length of the cutter bar.

Grain is no longer harvested while the heads are yellow (wheat, oats, etc.) or light brown (some sorghums) or just after the stalk has turned from its green color, because grain is just past the dough stage when harvested at these times. When combines are used for harvesting, grain must be hard and dry. These machines dated almost as far back as the reaper, but they failed to make the continued and improved progress made by the binder and thresher or harvester. In the 1880's combines were used in the Middle West to cut and thresh wheat. They really became useful after gasoline power was made available.

2. Methods of Harvesting

The methods of harvesting are:

- a. Combining - The combine is the most widely used of all harvesting equipment and is a mower-thresher machine that performs several harvest operations. The stalk is cut, grain threshed and transferred to a bin or is sacked and the straw is distributed in windrows or scattered over the ground. Combines are used to harvest grain sorghums, wheat, oats, barley, rice, flax, soybeans, peas and many other seed crops. The time required to cut one acre of wheat by hand and by machine is given on page 3. The difference varies from 1/2 to 46 hours.

Transparency No. 3

Operating Cycle:

The reel (1) momentarily holds the crop against the guards until the knife (2) cuts the stems, and then sweeps the cut material onto the platform. The platform auger (3) delivers the cut grain to the feeder (4) which carries the cut grain to the cylinder (5). The grain is rubbed out of the head between the rotating cylinder (5) and the concave grates (6). The cylinder beater (7) strips the cylinder, continues separating loose kernels of grain through the finger grate (8) then moves the material onto the straw rack (9) where final separation takes place. The adjustable cylinder beater check flap (10) regulates the flow of material over the racks. The grain pan (12) catches the grain separated at the concave cylinder beater grate, and returns it from the straw racks and delivers it to the chaffer (11). The cleaning fan (15) supplies

COMPARISON OF HAND HARVEST TO MACHINE HARVEST

Man-hours Required to Harvest 1 Acre of Wheat
(Courtesy International Harvester Co.)

Cutting with <u>sickle</u>	<u>14 hr.</u>	Cutting with <u>cradle</u>	<u>5 hr.</u>	Cutting with McCormick's first (4 1/2 ft.) <u>reaper</u>	<u>2 hr.</u>	Cutting with 5-ft. grain <u>binder</u>	<u>3/4 hr.</u>	14 ft. <u>combine</u>	<u>1/2 hr.</u>
Binding by hand	5 hr.	Binding by hand	5 hr.	Binding by hand	5 hr.	None		None	
Shocking	1 hr.	Shocking	1 hr.	Shocking	1 hr.	Shocking	1 hr.	None	
Threshing with flail	13 hr.	Threshing with flail	13 hr.	Threshing with flail	13 hr.	Stationary thresher	1 1/4 hr.	None	
Windrowing rod and sheet	10 hr.	Windrowing rod and sheet	10 hr.	Windrowing rod and sheet	10 hr.	None		None	
Gathering and sacking	<u>3 hr.</u>	Gathering and sacking	<u>3 hr.</u>	Gathering and sacking	<u>3 hr.</u>	None		None	
	<u>46 hr.</u>		<u>37 hr.</u>		<u>34 hr.</u>		<u>3 hr.</u>		<u>1/2 hr.</u>

Versatility of Combine

CROP	SPECIAL SIEVE (OPTIONAL)	RECOMMENDED EXTRA EQUIPMENT																
		Bean Concaves	Bean Elevator	Clover, Alfalfa Concaves	Corn Head	Cylinder Filler Bars	Fan Dirt Shield	Fan Housing Shield	Fan Inlet Screen	Perforated Grain Pan	Perforated Shoe Floor	Pickup Unit	Roto Cleaner with Proper Screen	Rub-bar Concave Fillers	Slow Cylinder	Speed Sprockets	Stone Trap	Wide Rear Axle
Alfalfa	3/32"*			X								X						
Barley												X						
Corn	3/8"*																	
	5/8"*				X	X		X										X
Edible Bean	3/8"*					X	X			X	X	X	X		X	X	X	
	1/2"*	X	X			X	X			X	X	X	X		X	X	X	
Soybeans	3/8"*																	
	1/2"*											X				X	X	
Sugar Beet	9/32"*											X				X	X	
Clover	3/32"*																	
	1/8"*			X								X	X					
Flax	3/16"*																	
	5/32"*									X	X	X						
Grasses	1/8" x 3/4"a																	
	1/8", 5/32", 3/32", 5/64"*																	
Grain Sorghums	1/8" x 3/4"a																	
	9/32"*																	
Oats								X			X	X						
Field Peas	3/8"*									X	X							
	1/2"*									X	X					X	X	
Rice	1/2"*																	
	5/8"*											X						
Rye	1/8" x 3/4"a											X						
Wheat	1/8" x 3/4"a							X				X						

* - Round Hole
a - Oblong Hole

the wind blast which is the medium of separation. The shoe and sieve (13) operate directly opposite to the grain pan and chaffer which assures double action cleaning (as the grain pan and chaffer moves forward, the shoe and shoe sieve move towards the rear). The shoe sieve (13) is where the final cleaning takes place. The threshed grain falls through the chaffer, shoe sieve, and into the grain trough (14) where it is moved to the grain elevator by the grain auger. The grain elevator conveyor chain then delivers the clean grain to the grain tank. Unthreshed heads will move rearward across the chaffer and shoe sieve and drop into the tailings return auger trough (16). From this point, the unthreshed heads are returned by the tailings elevator to the cylinder for rethreshing. The size sieves for some major crops are listed on page 4.

Transparencies Nos. 4, 5, and 6

- b. Hay Harvesting - Hay is harvested in several different ways for local use and marketing. The most common ways hay is harvested for marketing are in the form of rectangle bales and cubes. Loose and chopped hay is no longer harvested in large quantities due to storage problems and problems in handling when moving it to and from the storage area. In some areas where the weather is a hazard to curing hay, barns are equipped with drying systems to finish drying the half cured (35 to 40 percent moisture) hay. This type of hay curing was developed for loose and chopped hay, and in areas where rainfall is a harvest problem.

Many different types of equipment and machines are used in harvesting hays and forages. The most common equipment is as follows:

Mowers - The cutterbar is common to all methods of harvesting. The cutterbar is mounted at the rear of a tractor and operated off the power take-off.

Mower-Conditioners - A mower-conditioner has a cutterbar mounted in front of the unit. A bar pushes the plants forward so that the cut end is fed into the conditioner rollers which crush the stems allowing the hay to dry more rapidly. In fact, drying can be speeded up 50 percent. As the hay passes through the machine it is worked toward the center before being dropped to the ground, forming row appearance.

Rakes - If a regular windrower is not used, the hay must be raked into windrows. The reel type side delivery rake is most commonly used. However, another very popular rake is the wheel type. They can be used on sparse crops where the ground is rough. Dump and buck rakes are used mainly to move loose hay from one location to another.

Balers - Rectangular balers take up hay from the windrows, compress it, and tie the bales with two or three strands of sisal, hemp, plastic, or band of wire. Hay is fed into a chamber, compressed by a plunger, and cut to a standard width by a set of knives before it is tied. Bales may vary in length from 36 to 48 inches and weigh from about 60 to 75 pounds. Round balers are becoming more popular. This type of baler forms a round bale by taking the hay from the windrow and rolling it into a tight round shape. The hay is tied with sisal or plastic. Round bales are stored outside or under open sheds until they are moved to the pasture for feeding. Special equipment is needed for handling round bales. They are transported to the storage area and then to the pasture by using a fork lift mounted on the tractor or special bale movers hooked to tractor or pickup. There are several different sizes of round balers. The most common is the 1500-pound bale size. The largest baler is of the stack-wagon type. They are of two types, mechanically-compressed and air-packed. Sizes may vary from 1 to 10 tons. The mechanical-pressed stacks are grouped in 1, 3, and 6-ton sizes. These units gather hay from a windrow similar to other balers.

Moving Equipment - Flat bed trailers, pick up and delivery bale handlers, three point tractor bale movers, and front-end tractor loaders are necessary to properly handle hay.

Field Cubers - This machine takes up the hay from a windrow, moistens the dry hay, cuts it into less than 1 1/2 inch lengths, and forces it through a small die. As the cubes are discharged from the cubing machine, they are delivered to a trailing hopper. Cubes are stored in bins (rooms) and must not contain more than 15 percent moisture.

Transparency No. 7

- c. **Ensiling** - Ensiling is a method of preserving forage crops in the green stage so that they can be used as a succulent feed. The small chopped pieces of forage plants are usually stored in silos. Corn, sorghums, certain grasses, clover and vetches are used as silage crops. The two types of ensiling machines (forage harvesters) are: Field choppers and flail choppers. The field chopper is by far the most versatile of the two types. This versatility comes from its ability to harvest both row and broadcast crops.

Three processes are involved in the operation of the forage harvester.

Cutting and feeding
Chopping
Blowing

The feeding and cutting mechanism will vary according to the type of unit attachment used on the harvester. If a row crop unit is being used, an oscillating sickle is used to sever the plants. The plants are moved back toward the chopping unit. If a broadcast unit attachment is used, a mower-like cutter-bar cuts the crop. A reel is used to throw the severed plant against an apron which carries the forage back to an auger. The auger in turn carries the material to the chopping unit. If a windrow pick-up is used, revolving fingers lift the forage from the windrow and move the hay to the auger. The auger in turn moves the forage to the chopping mechanism. The unit is usually powered through the PTO and the tractor.

Transparencies Nos. 8 and 9

- d. **Picking and Stripping Cotton** - A cotton picker removes locks of seed cotton from the open dried burr. It performs the same type of work that was once accomplished by hand labor.

Pickers may be classified according to the way they are powered. There are cotton-picking units (one and two row) that are made to mount on tractors. The most modern type unit is self-propelled. The mechanical features of different brand names may be different. The main differences are the number of rows harvested, type of spindles, height of drums, and method of mounting pickers on tractors. The basic units of a picker are: the picking unit, fan delivery system, platform, controls, and the cotton basket. The major difference in cotton picker operation is in the operation of the spindles that remove the seed cotton from the plant. The two types of spindles are:

Tapered Tooth - This spindle has three or four rows of teeth which catch and hold the lint cotton as the entire lock is wrapped around the spindle.

Straight Spindle - This spindle may have a row of teeth or a rough surface that removes the lock from the boll.

The principal parts of the cotton picking unit and their functions include:

Stalk lifters, spring fingers, and grid bars move cotton stalks into the picking area.

In the picking unit there are hundreds of spindles carried on spindle bars. Spindles rotate at 90 degrees to the direction of travel as they remove seed cotton from the stalk. A typical machine will have twenty spindles on each vertical bar. The bars are mounted on two

drums (one on each side of the row). Spindles rotate and entangle and extract seed cotton from the open boll.

Doffers remove the cotton from tapered spindles after they leave the plant. The stationary rubber face doffers drop the seed cotton so that it can be picked up by air from the conveyor. Cotton from straight spindles is removed by stripper bars as the spindle passes the bar. The rubber cleaning pads are moistened as they clean the spindles.

Cotton is conveyed to the carrying baskets by a fan that draws cotton from the drum through conveyor pipes. Dirt and trash are extracted from the cotton through grates by the air blast before it reaches the carrying baskets.

Cotton strippers remove the dried open boll from the plant. The boll contains fiber and seed. Before a successful stripping job can be accomplished, plant leaves must be removed either by defoliation or by frost. Most cotton strippers are made to harvest stormproof cotton (lint not fluffy and held tight in boll). The two most commonly used strippers are the single and double roll and tine or finger type. Some types of strippers are mounted on tractors or pulled by tractors. The latest and most modern models are self-propelled. The main parts of the roll-type and tine-type are:

Roll Stripper Parts - Pick up grates or lifters, rolls or roll and bar, auger conveyor, pressure plates, fingerbeaters, fan, and conveyor chute.

Tine-Type Stripper Parts - Pick up and stripping fingers, upper and lower beater conveyors, cleaner screen, auger, and conveyor chute.

Transparency No. 10

e. Digging Roots and Tubers

The potato digger changed potato production from a garden project to a commercial enterprise. There are 1 and 2 row machines pulled behind a tractor. The digging blades and shaking apron are operated from the power take-off. Most diggers deposit potatoes on the ground to permit the skin to dry before they are placed in crates or sacked by hand. Some of the larger machines deposit the potatoes in a tank mounted on the machine and others deliver the potatoes onto a truck driven close to the

harvester. Most commercial potato producers destroy the vine before harvest by using a chemical, or they use a frill-beater.

Other root-harvesting equipment includes sweet potato harvesters, sugar beet harvesters, and peanut diggers and combines. There are machines that dig, shake, windrow, and invert peanuts, whereas others only dig or shake the vines. The two main types of machines that are used to separate the peanut from the vine are threshers and pickers. The thresher has teeth similar to teeth on a grain thresher, which are straight. Yet, they are spaced much farther apart on the cylinder and concave bars. The cylinder and concave bars on a picker have spring teeth. Peanut combines are both tractor-drawn and self-propelled. They may be equipped with a holding tank or bagging attachments. Usually combined peanuts must be dried before being placed in storage.

f. Special Harvesting Equipment

Special harvesting equipment is as follows:

Sugar-Cane Harvesters and Other Equipment - The dead leaves are removed by burning. The heavy (16,000 lb.) self-propelled machine enters a burned over field, cuts the thick stalks near the ground, and removes the tops by power-operated knives. Cane is placed in windrows by the harvester. A special loader picks up the cleaned stalks, which may be 8 to 12 feet long, and loads them on a special trailer or truck designed for hauling cane.

Tree Harvesting Equipment - Tree shakers are used to loosen nuts and fruit from the branches. Catcher-conveyors catch the nuts or fruit and transfer the produce to containers or holding tanks. Where it is necessary to harvest fruit by hand from tall trees, self-propelled, hydraulic orchard lifts equipped with a conveyor and a crating unit make up part of the lift equipment.

Vegetable or Truck Harvesters - Cantaloupe, cabbage, lettuce, and pineapple are harvested by hand picking the produce, placing it on a conveyor that extends over the rows, and elevating the produce into a tank, trailer, or truck. Machines have been developed that will harvest onions, carrots, cucumbers, radishes, grapes, tomatoes, berries, and other similar crops.

Transparency No. 11

- g. Hand Harvesting - It is necessary to continue to harvest certain crops by

hand. This oldest method of harvesting is practiced more in growing vegetables, fruits, and nuts than in growing regular field crops such as corn, grain sorghums, and cotton. Some vegetable and fruit crops that require complete or limited hand harvesting are:

Cantaloupe	Broccoli	Oranges
Cucumbers	Cabbage	Lemons
Squash	Cauliflower	Grapefruit
Vine Beans	Lettuce	Plums
Peppers	Tomatoes	Pears
Eggplant	Radishes	Grapes
Okra	Melons	Peaches
		Apples

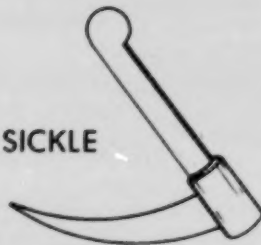
- h. Improving Soils - Legumes and some grasses are planted to improve the organic content of the soil. After a crop has reached the bloom or booting stage it is plowed under. It may be necessary to plow under a crop before it reaches maturity so the main crop can be planted on time during the spring. This method of harvesting a crop is practiced to improve the fertility of the soil.

References:

1. Delorit, Richard J. and Others, Crop Production, Prentice-Hall Inc., Englewood Cliffs, New Jersey, 1974.
2. Heath, Maurice E. and Others, Forages, The Science of Grassland Agriculture, The Iowa State University Press, Ames, Iowa, 1976.
3. Smith, Harris Pearson, and Lambert Henry Wilkes, Farm Machinery and Equipment, McGraw-Hill Book Company, New York, New York, 1976.

HAY AND GRAIN HARVESTING EQUIPMENT

EGYPTIAN SICKLE



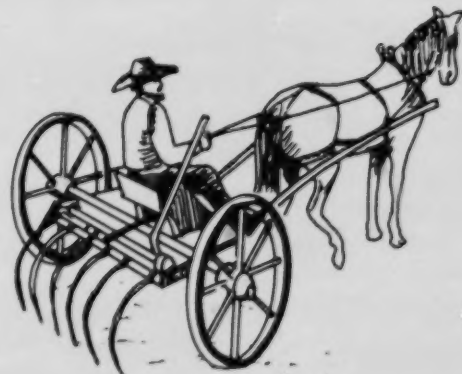
SICKLE



SCYTHE AND CRADLE

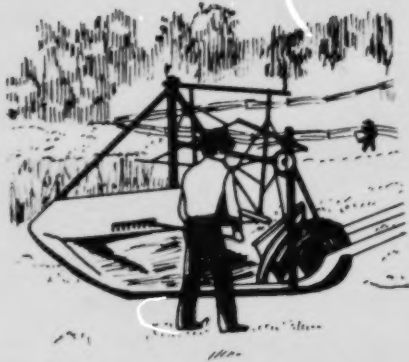


SICKLE MOWER



EARLY RAKE

HAY AND GRAIN HARVESTING EQUIPMENT



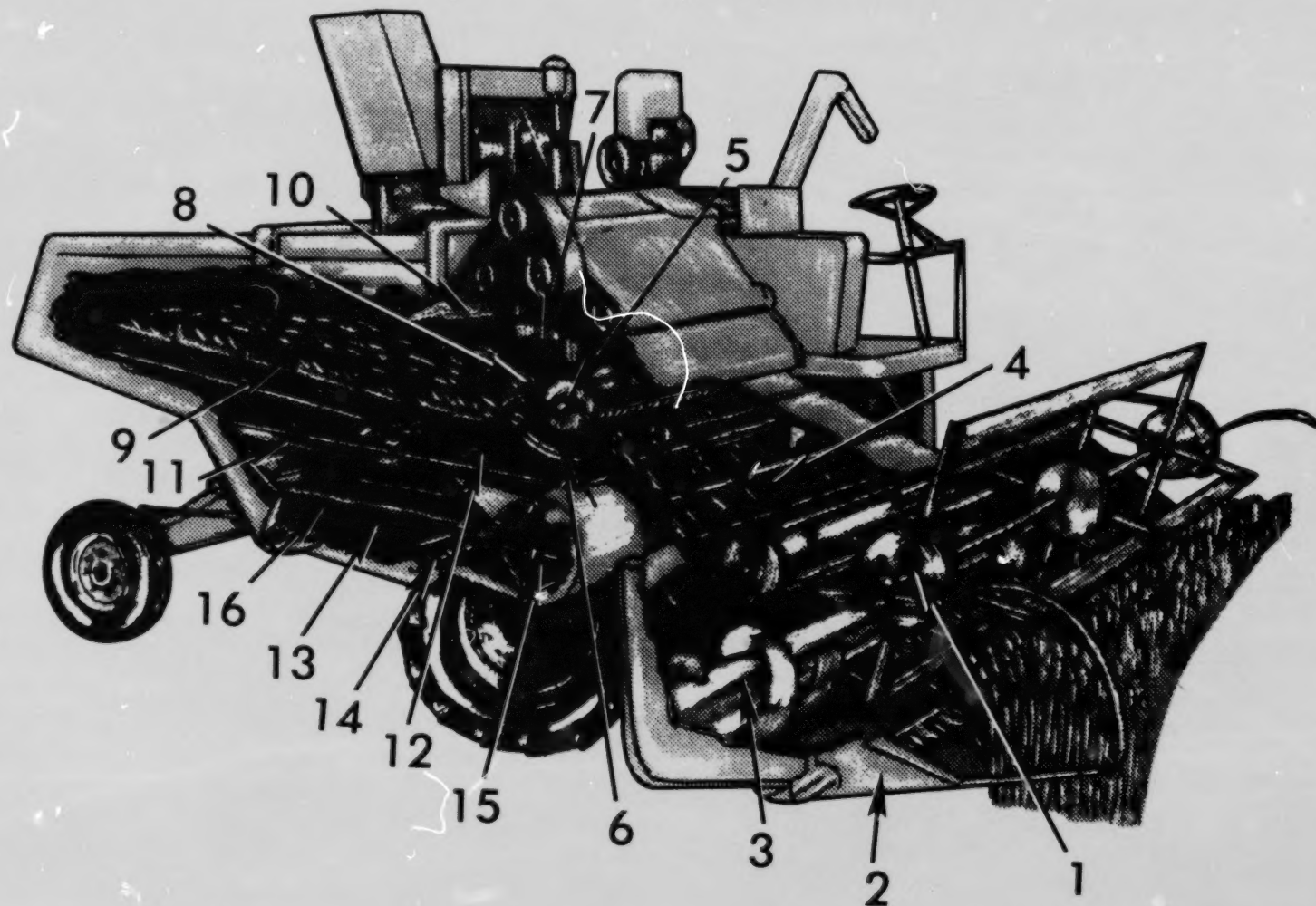
REAPER

BINDER

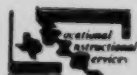


STATIONARY HAY BALER

COMBINE



401

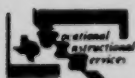
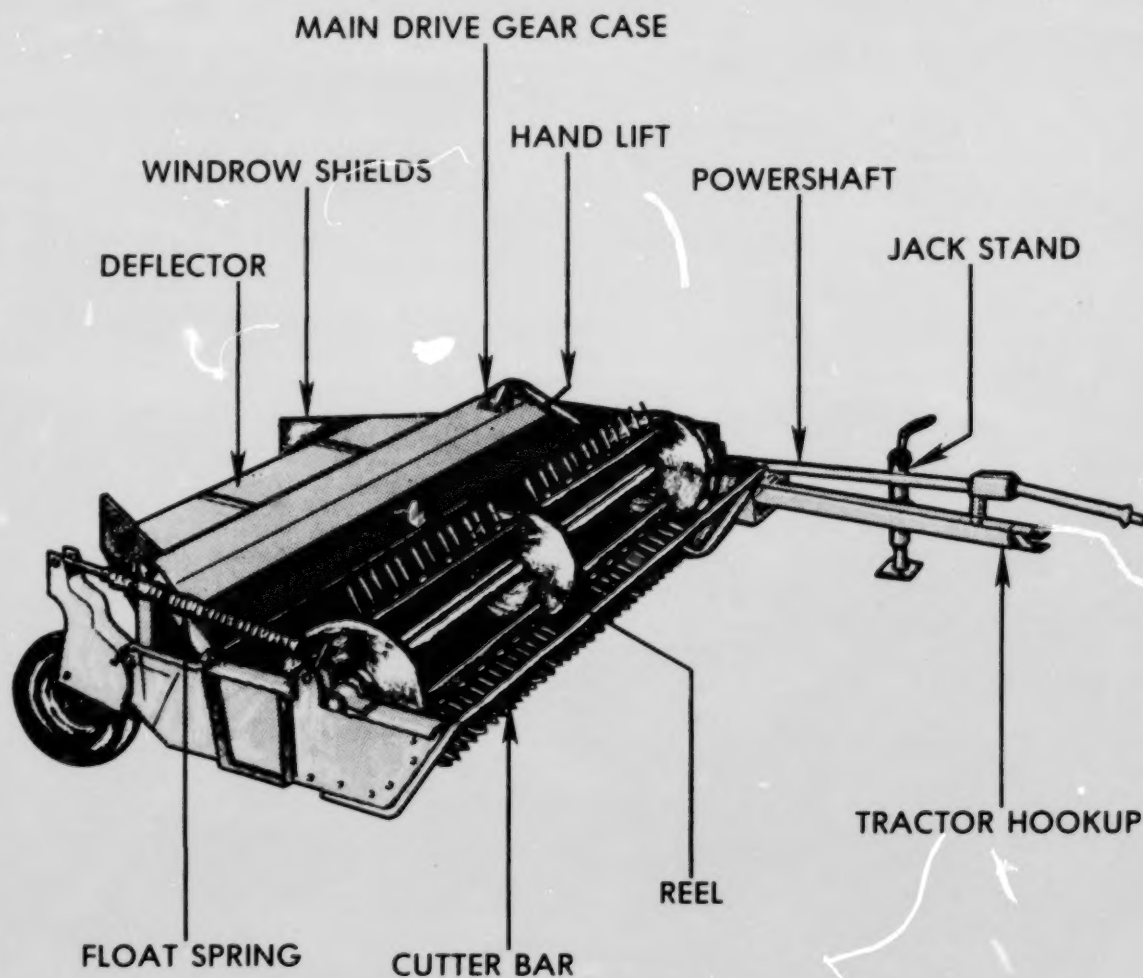


V. A. III

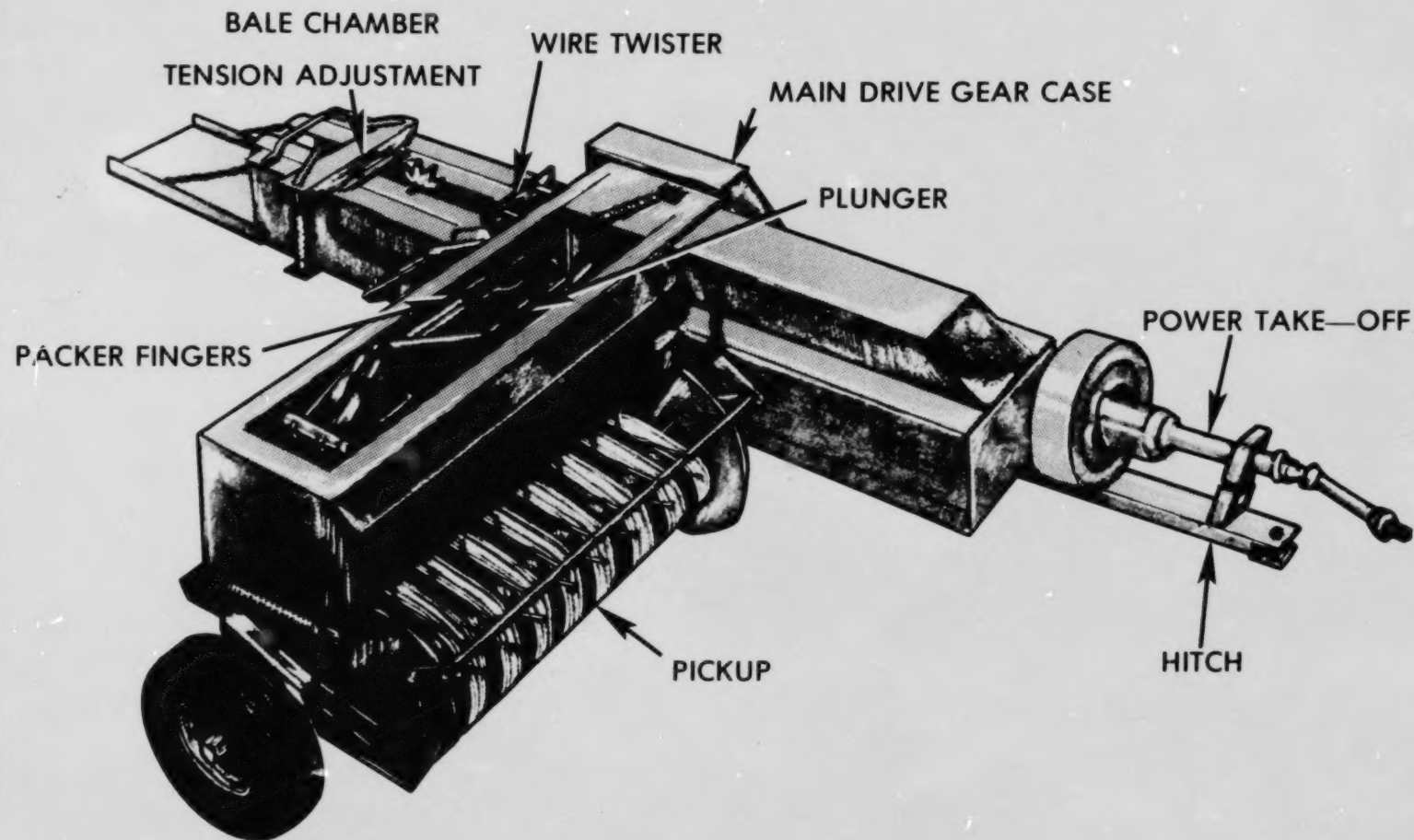
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No. 3

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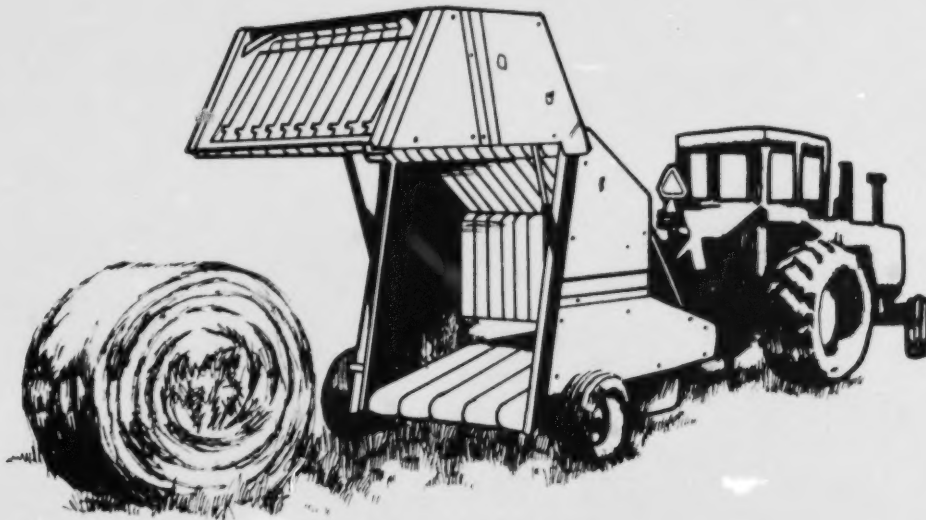
MOWER AND CONDITIONER



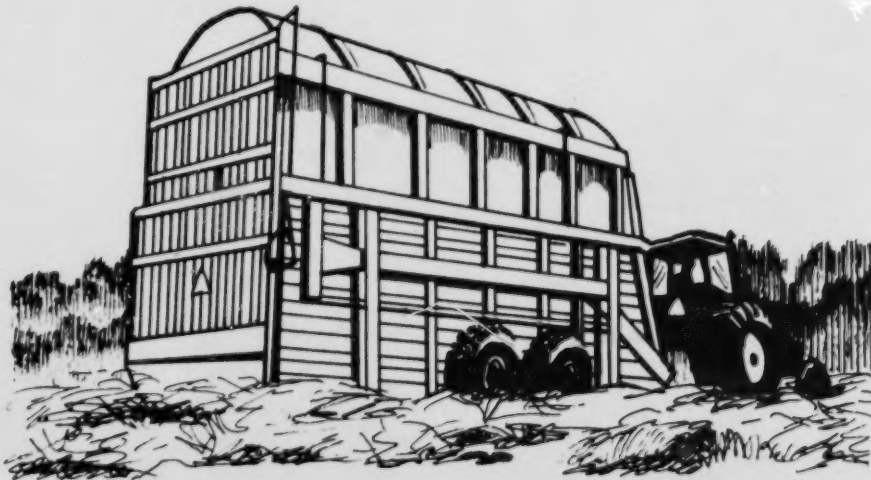
HAY BALER



HAY BALERS

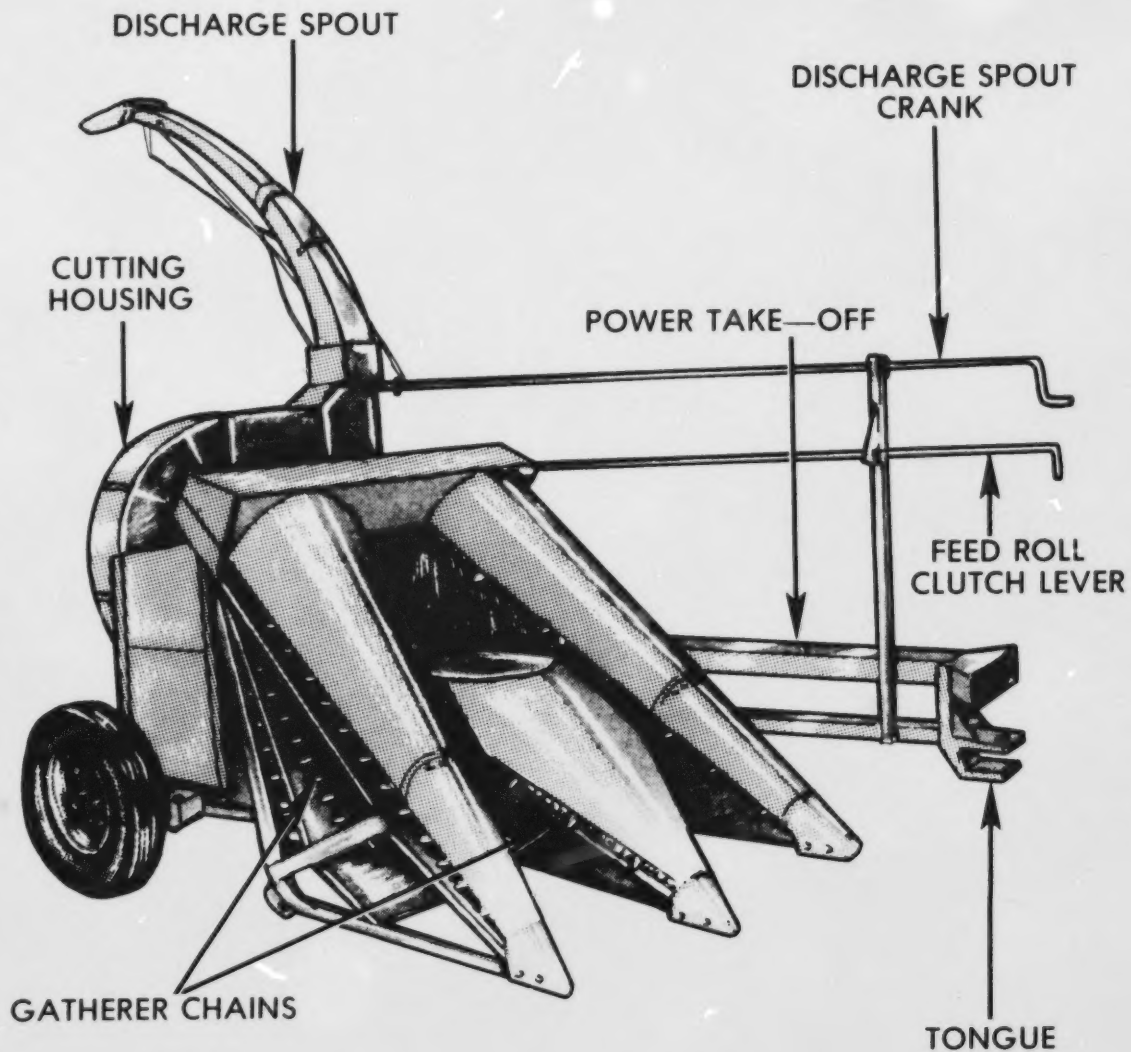


ROUND BALER

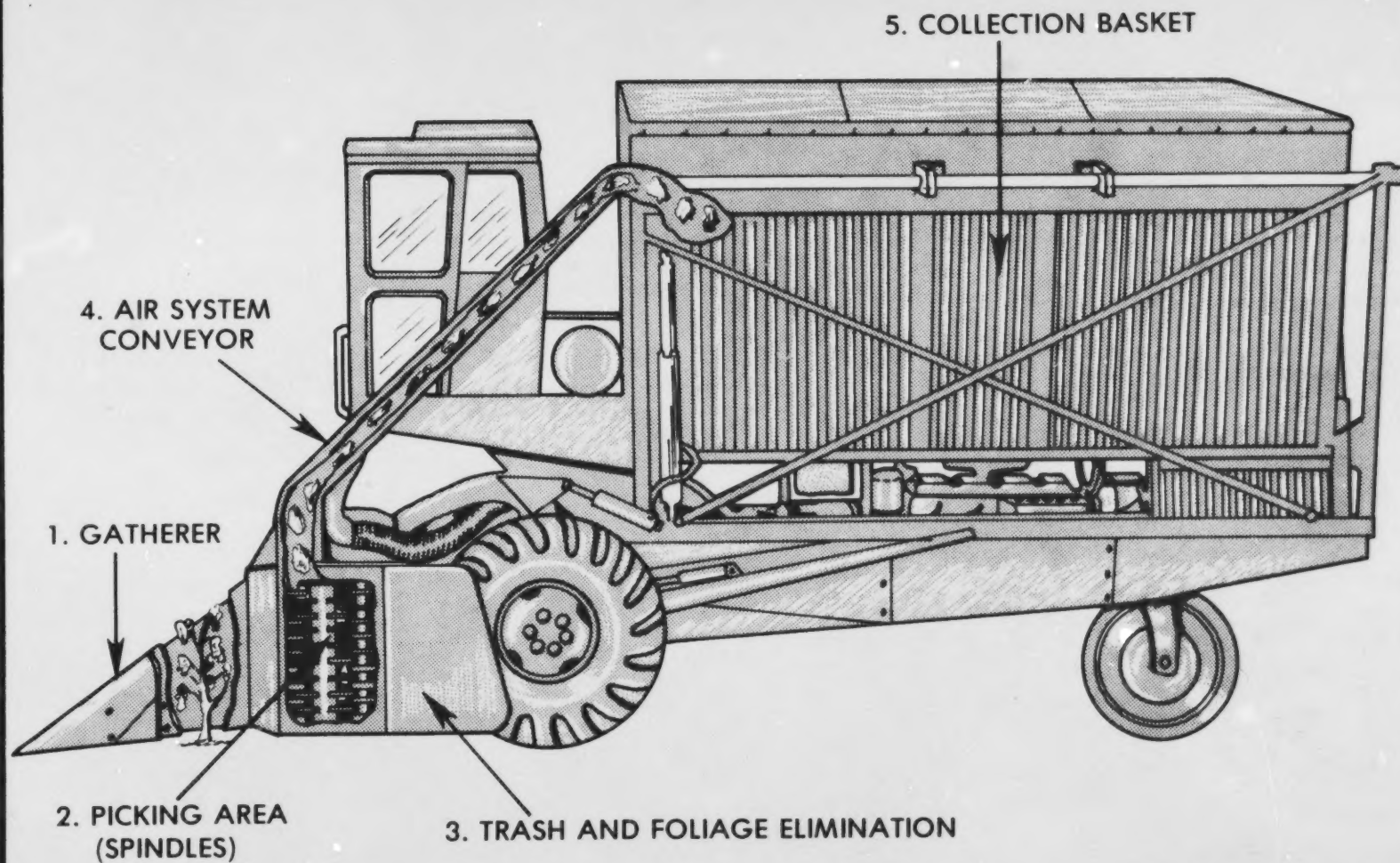


STACK-WAGON BALER

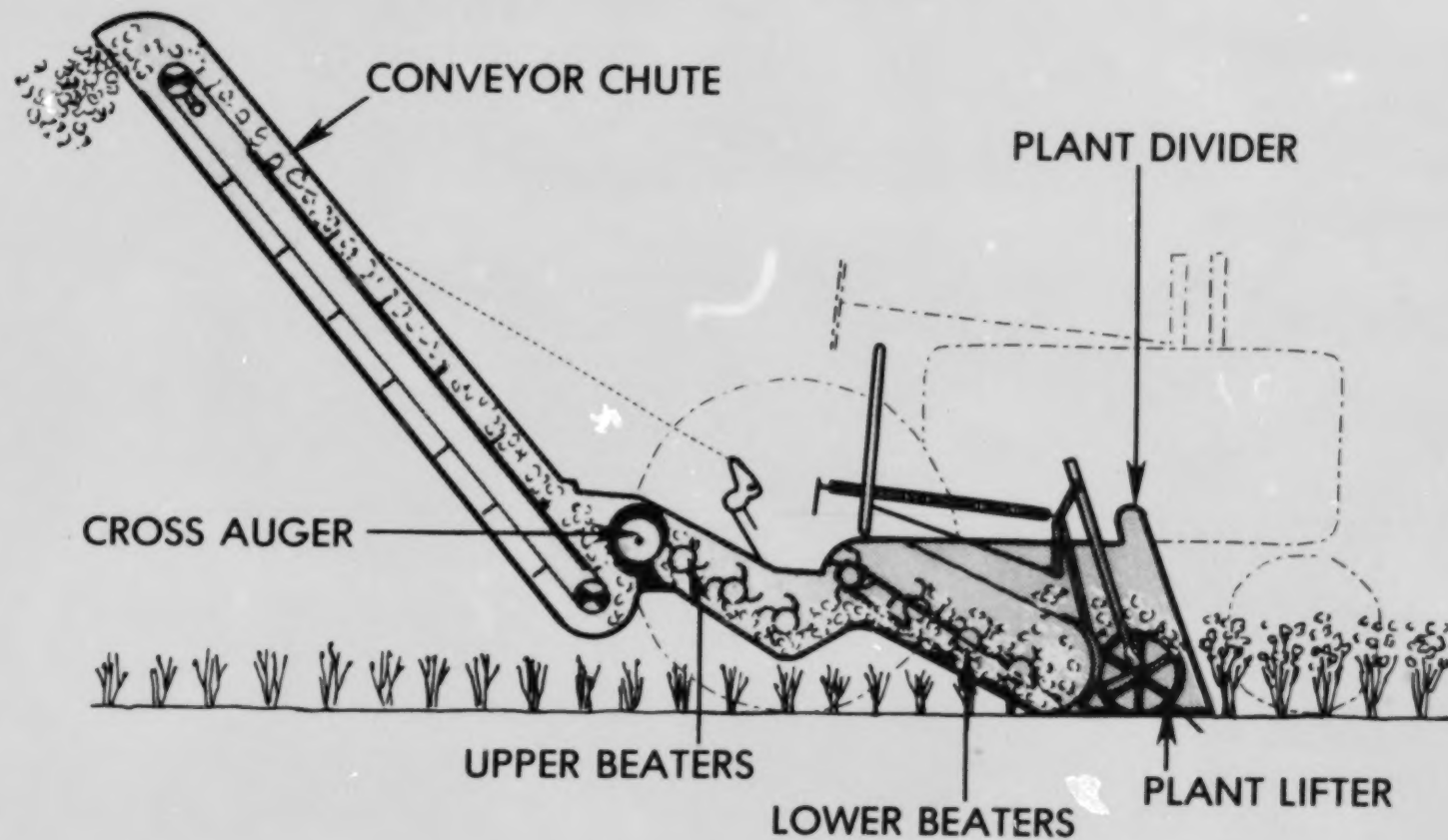
FORAGE HARVESTER



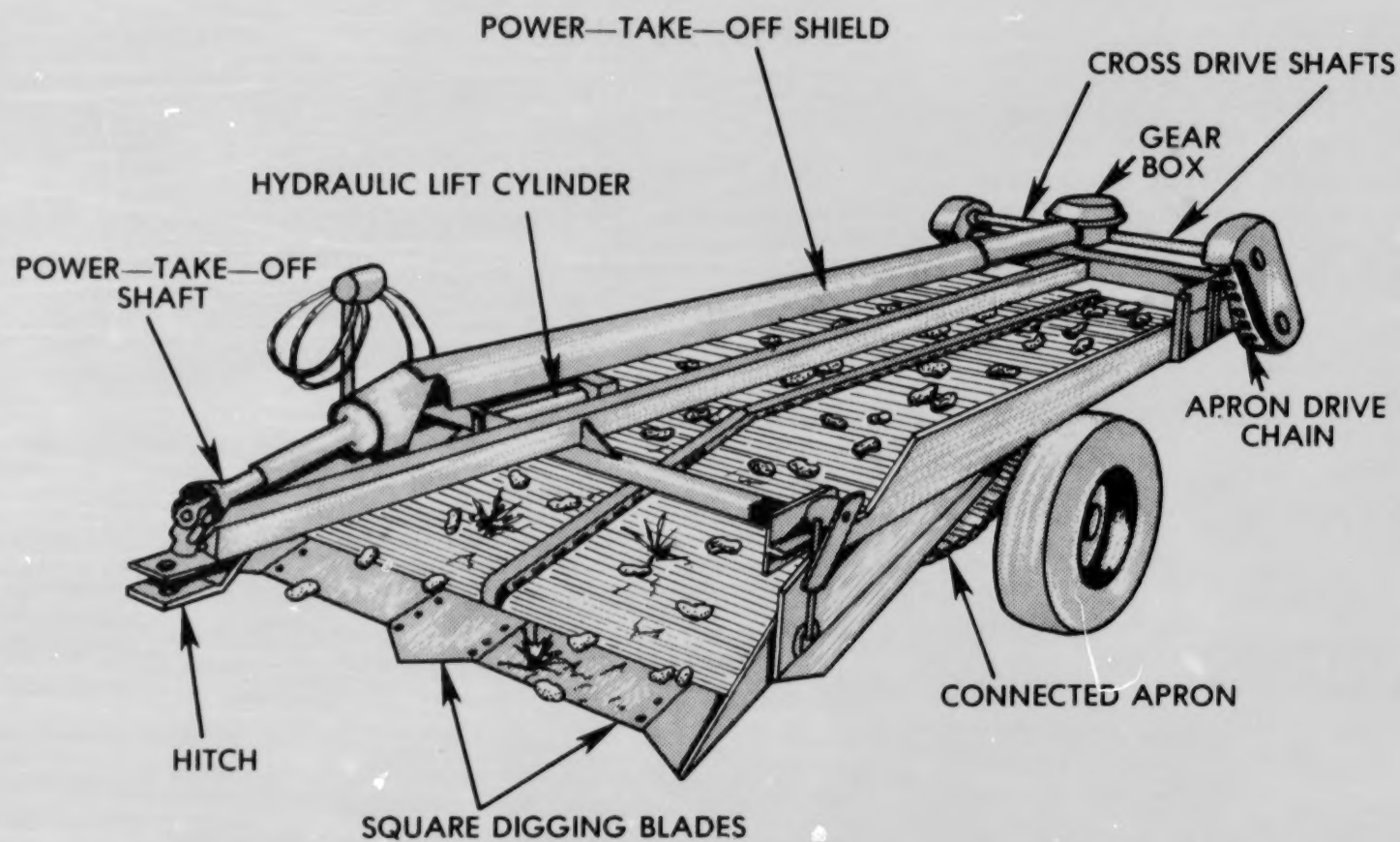
COTTON PICKER



COTTON STRIPPER



POTATO HARVESTER



HAND HARVESTING

BROCCOLI
CABBAGE
CAULIFLOWER
LETTUCE



CANTALOUPE
CUCUMBERS
SQUASH
VINE BEANS



PEPPERS
TOMATO
OKRA
EGGPLANT



ORANGES
LEMONS
GRAPEFRUIT
PEACHES



PLANT SCIENCE

Unit B: Harvesting

Topic 2: Handling, Grading, and Packing

Suggested Procedures and Activities: The use of crop and vegetable samples that may identify grades and a display of several different packing containers will be of value while discussing the topic.

1. The Establishment of Standards

Standards were first established by the Egyptians and Romans. The Egyptians invented the "standard" of length and the Romans developed a set of standards for weights and measures. These were minimum standards for trading in the market place. They differed from grade standards, in that, they did not include the many characteristics which determined the actual quality of a product.

During the 12th Century Great Britain developed the "assize (ordinance) of bread", which became a factor for marketing food products. The bread ordinance established prices based on the contents and quality of the finished product. The early English Penny (Sterling) weighed thirty-two Grains of Wheat, dry in the midst of the Ear. The best standard measures then known were the foot, hand, and grains of wheat.

Thomas Jefferson, who previously sponsored the decimal system of coinage, established the measure for a gallon (270 cubic inches) for dry and liquid matter.

The following Acts established standards and grades for most agricultural commodities.

The Cotton Futures Act - This Act was passed in 1914 and established the Department for Standardization of Cotton. The standards were made compulsory in the New York and New Orleans Cotton Exchange.

The Grain Standard Containers Act - This Act consists of a law passed by congress standardizing 2-quart, 4-quart and 12-quart Climax baskets. The standards included the dry quart and multiples of it for fruits and vegetables.

The Grain Standards Act - This Act established Federal standards for grain when sold through the interstate commerce agency.

The Food Production Act - This Act provided authority to establish standards and inspection services for vegetables and fruits and other food products.

The Agricultural Marketing Act - This Act was established in 1946 to give the Secretary of Agriculture broad powers in developing and establishing standards for most farm commodities.

2. The Purpose of Standards

The major purpose in establishing standards in crop marketing is to eliminate abuse in the market. Most standards which affect the quality of crop products are introduced through law.

Standards provide a foundation for our marketing system. When products are compared with a set of standards, the products are grouped into grades.

Standards protect the farmer, buyer, and consumer. The farmer demands certain standards or guidelines when selling his product. Industry also demands certain standards which will improve the marketing of its products. The public or consumer needs guidelines for buying a product.

3. Channeling From Producer to Consumer

Transparency No. 1

Many crops are harvested, graded and packed entirely by machinery. For example, after grain is combined, it is weighed, tested for moisture, dumped in the elevator, sometimes sent through the dryer, then trucked to a buyer or processor. The grain is handled entirely by machinery, except for sampling, to record grade and moisture content. Cotton and hay crops are handled by machinery. There is one exception, most of the hay is loaded in the field by hand onto a truck, instead of being loaded by an automatic loader, even though several types of loaders are on the market. Baling methods have changed since 1970. In many areas of the state hay is being baled in round and large rectangular bales. Due to the weight and size of these bales, they must be handled entirely by machinery built for that purpose.

Fruits and vegetables are handled somewhat differently from grain, oil and fiber crops. Harvesting, loading for transportation from the field, grading, cleaning and even packing may require hand labor.

Each year improvements are made in mechanizing the handling of fruits and vegetables. Fruits and vegetables are considered perishable foods; therefore, special care must be practiced in order to preserve the product. Most vegetables and fruits require precooling after harvest. They must be packaged or crated in order not to disturb the tissue.

Table No. 1 - Fruits and Vegetables

Crop	Handling	Grading	Packing
Snap Beans	Cool in bushel hampers	U. S. Fancy, No. 1, and No. 2	Field - 12 qt. to 50 baskets 1 to 2# packs and loose; mostly canned (bu. wt. is 28 to 30 lbs.)
Cabbage	Transferred from field in crates; sold by head	U. S. No. 1 and U. S. Commercial	Field - Crates and bags holding 50 to 80 pounds
Cantaloupes	Transferred to sheds for washing, waxing, and packing	U. S. No. 1 and U. S. Commercial Jumbo	Waxed and packed in crates. Carton size - 18 to 45 melons
Carrots	Washed and cooled; precooled	U. S. No. 1 and U. S. Commercial	Packed in polyethylene bags, 48 bags to crate
Sweet Corn	Unloaded from field into bins for sorting; precooled	U. S. Fancy, No. 1, and No. 2 According to size and fullness	Wirebound crates and polyethylene bags
Cucumbers	Transferred to sheds for washing and waxing; precooled	Fancy No. 1, No. 2 and No. 3	Most are canned and not packaged. When packed, crates or cartons are used weighing 50 to 55 lbs. (1 bu.)
Lettuce	Packed in crates in the field; vacuum cooled	U. S. No. 1, No. 2, and Unclassified	Packed in polyethylene bags and crated in fiber-board or wirebound boxes

Table No. 1 - Fruits and Vegetables (continued)

Crop	Handling	Grading	Packing
Turnip and Mustard Greens	Cooled to near 32° F after packing in crates in field	U. S. No. 1 Commercial	Bushel basket or wirebound crates, 18 to 20 pound size
Onions	Transferred in bulk to packing house; precooled	U. S. No. 1, No. 2, and No. 3, Commercial Bermuda, Creole and Northern Grown	Cotton and paper mesh bags - 3 to 50 pounds
Potatoes	Transferred to storage or packing plant; unloaded by forks; dry brushed or washed before packing	U. S. Fancy, No. 1, Commercial, and No. 2	Packed in 5, 10, 15 and 25 pound bags
Radishes	Shipped in crates and baskets; precooled	U. S. No. 1 and Commercial	12 and 16 quart crates hold 8 oz. film bags
Tomatoes	Transferred to packing house in bulk form; defects and color sorted by hand	U. S. No. 1, No. 2, No. 3 and U. S. Combination	Wooden flats holding 8 to 40 pounds
Grapefruit Lemons Oranges	Picking bags dumped into bulk; boxes delivered to packing plant; washing, de-greening, waxing	U. S. Fancy No. 1, No. 2, No. 3, U. S. Combination	Polyethylene, fiber bags, wirebound crates, fiberboard boxes. Most lemons are shipped in fiberboard cartons containing 38 pounds

Table No. 1 - Fruits and Vegetables (continued)

Crop	Handling	Grading	Packing
Peaches	Precooled if shipped a great distance from orchard	U. S. Fancy, Extra No. 1, No. 1, and No. 2	Cell cartons, fiberboard trays, bushel basket and half-bushel baskets
Strawberries	Transferred from field container to sale containers	U. S. No. 1 and No. 2 and U. S. Combination	Usually shipped in crates containing pint or quart tills or cups
Watermelons	If transferred from harvest, truck loaded by hand or bin to truck or freight car	U. S. No. 1, No. 2 and Commercial	Shipped in bulk or container holding up to 16 melons
Okra	Transferred from field after hand harvesting to shaded area	U. S. No. 1 and Damaged	Shipped in bushel baskets or cartons weighing 30 pounds or a lug weighing 18 pounds
Pears	Hand picked and transferred to packing area	U. S. No. 1, No. 2, U. S. Combination	Shipped in wooden and fiberboard boxes and baskets. Bushel weighs 47 to 54 pounds

Transparency No. 2

Fruits and vegetables follow two general routes from the farm to the retail store. If the produce is fresh, it is hauled to a packing shed and then to the wholesale market warehouse. Those to be processed go to the processing plant and then to a wholesale warehouse. All fruits and vegetables are handled about the same through both of these marketing channels.

4. Grading of Crop Products

Transparency No. 3

Grading establishes a common language understood by the buyer and seller as a basis for judging the quality of a product in relation to its sales price. This forms a foundation for practically all transactions.

The quality of grain and cotton as well as most fruits and vegetables bought and sold in various commodity exchanges is designated in the terms of federal grades.

The price received for a given commodity is not always determined by the grade. For example, some markets pay a premium for certain varieties of potatoes, apples, and peaches because of size, shape, or color.

Many factors affect the grades of grain crops, fiber crops, and fruits and vegetables. The following grading factors may be identified according to symbols for the major crop division affected: (Grain Crops G, Fiber Crops F, Fruit Crops FC, and Vegetable Crops V):

Proper size (G, F, FC, V)
Good natural color (G, F, FC, V)
Proper shade (G, F, FC, V)
Fleshy and firm (FC, V)
Free of decay (G, F, FC, V)
Free of sunscald (FC, V)
Free of foreign material (G, F, FC, V)
Free of insect damage (G, F, FC, V)
Free of disease damage (G, F, FC, V)
Free of bruises (FC, V)
Properly matured (G, F, FC, V)
Relatively free of moisture (G, F)
Free of damaged kernels (G)
Length and strength of fiber (F)

Most fruits and vegetables are graded U. S. Fancy, No. 1, No. 2, No. 3,

Commercial and Combination, as shown in the illustration. Refer to Table No. 1 - Fruits and Vegetables, pages 3-5.

Factors that determine grades for grains are:

- Test weight
- Soundness
- Cleanliness
- Purity of type
- Dryness
- General condition

Grain is graded similarly to fruits and vegetables in that No. 1 is considered the best grade. Grain increasingly inferior is given grades down to No. 5, and even Sample grade if the grain is too poor in quality to meet the requirements of number grades. Grain is not graded Fancy, Commercial, or Combination the way fruits and vegetables are done. However, there are standards that cover the marketing of mixed feed oats and mixed grain.

Transparency No. 4

The grading of cotton is known as classification of cotton. Cotton classification is placed in two categories: cotton grade and cotton staple length and condition.

Grade - For grade, classification is based on appearance, which is accomplished through sight by using three factors: color, foreign matter (leaf or trash), and fiber preparation.

Staple - Is based upon the length of the fiber. It can be determined by sight and touch. However, length can be measured by using a rule graduated in 1/16 inch. Fibers are pulled out and compared to an official staple length. A sample is also used to determine the color, foreign matter, and fiber preparation.

As illustrated in Transparency No. 4, grade may be affected by the season or time of year cotton is harvested. Usually cotton harvested early (a) is whiter and cleaner than midseason (b) or late (c) cotton. Micronaire (mike) readings or tests are made on cotton to determine whether the fiber is classed very coarse, coarse, average, or fine. Textile mills are interested in an even-running mix. The mike is widely used in both domestic and international cotton trade.

5. Packing Crop Products

Transparency No. 5

The packing of crop products is larger than any other type of food packing industry. Large quantities of materials such as sawed wood, veneer, paper, paperboard, burlap, cotton, steel, glass, polyethylene, cellulose acetate, and aluminum foil are used to pack crop products.

There are many reasons for packing crop products. The most important ones are:

- To protect the form and quality
- To minimize damage from handling
- To lessen the chances of contamination
- Prevent the loss of moisture or protect the product from moisture
- Improve the handling of certain products
- Promote sales by making the product more attractive
- Minimize enzymic and chemical changes
- Improve the problem of storage and precooling

The different types of packing for shipment and sale are:

- A. Wood crates reinforced with wire
- B. Paperboard cartons, reinforced with corrugated paperboard
- C. Cups or tills, made of wood or plastic
- D. Burlap bagging and steel ties
- E. Polyethylene bags
- F. Bushel and one-half bushel baskets made of wood and wire
- G. Burlap or paper sack
- H. Paperboard crates with polyethylene trays
- I. Polyethylene, cotton, jute, or twisted paper bags

Small grains are usually packaged in burlap or paper bags. Cotton is packaged in burlap and steel ties. Vegetables and fruits are packaged in the containers shown in the illustration.

The packaging technique is often complex. The steps in machine packaging when using cartons are:

- Flexible or semiflexible flat containers for packaging dry materials are fed into the machine.
- The machine opens and sets up the cartons on a conveyor belt.
- Uniform filling by machine is possible if the cartons are shaken during the filling operation.
- Packages are weighed and rejected if improperly filled.
- Acceptable packages are sealed and placed in shipping containers.

When bags are used for packaging crop products, they are machine-filled, weighed, tied or sewed, and stored or loaded. However, many (fruits and vegetables) are packaged in crates, baskets and tills by hand labor.

Most crop products are shipped by truck. However, about one third of the crop of some fruit and vegetable products are shipped by freight cars.

Usually, shipping by truck requires less handling, less expense and gives a more rapid service.

References:

1. Childres, Norman Franklin, Modern Fruit Science, Horticulture Publications, New Brunswick, New Jersey, 1969.
2. Delorit, Richard J. and Others, Crop Production, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1974.
3. Janick, Jules and Others, Plant Science an Introduction to World Crops, W. H. Freeman and Company, San Francisco, California, 1974.
4. Heath, Maurice E. and Others, Forages - The Science of Grassland Agriculture, The Iowa State University Press, Ames, Iowa, 1976.

EXAMPLES OF CHANNELING FROM PRODUCER TO CONSUMER

GRAINS

Combine

Dryer

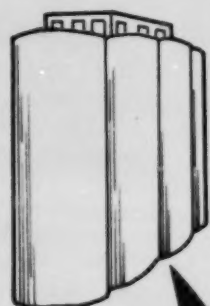
Elevator

Broker

Processor

Wholesaler

Retailer



FRUITS AND VEGETABLES

Picker

Grader

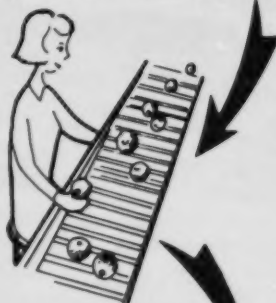
Cleaner

Packager

Broker

Wholesaler

Retailer



COTTON

Picker

Ginner

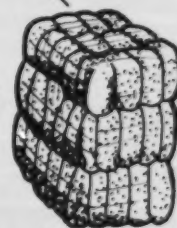
Warehouse

Grader

Broker

Processor

Wholesaler

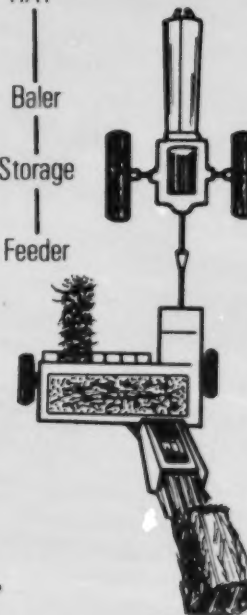


HAY

Baler

Storage

Feeder



PRINCIPAL MARKETING CHANNELS FOR FRUITS AND VEGETABLES



FACTORS AFFECTING THE GRADES OF CROPS

GRAIN CROPS (G)

FIBER CROPS (F)

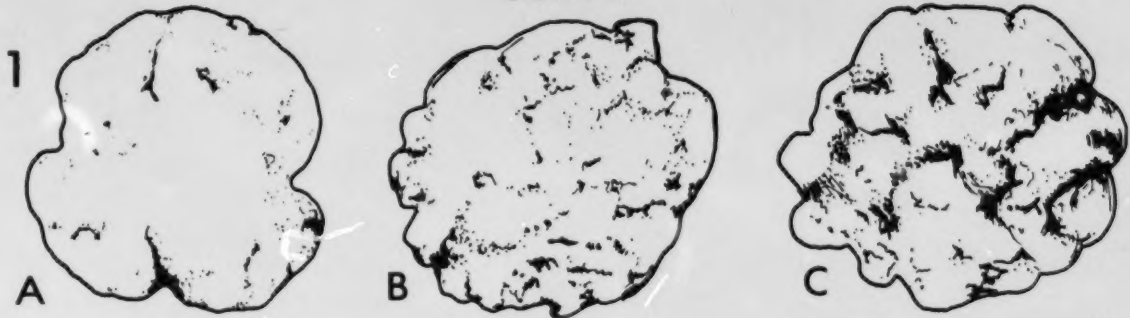
FRUIT CROPS (FC)

VEGETABLE CROPS (V)

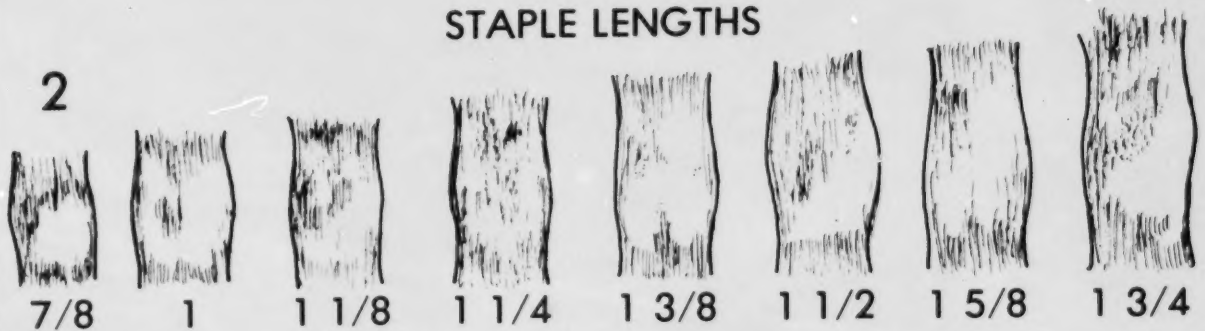
Proper size	(G,F,FC,V)
Good natural color	(G,F,FC,V)
Proper shape	(G,F,FC,V)
Fleshy and firm	(FC,V)
Free of decay	(G,F,FC,V)
Free of sunscald	(FC,V)
Free of foreign material	(G,F,FC,V)
Free of insect damage	(G,F,FC,V)
Free of disease damage	(G,F,FC,V)
Free of bruises	(FC,V)
Properly matured	(G,F,FC,V)
Relatively free of moisture	(G,F)
Free of damaged kernels	(G)
Length and strength of fiber	(F)

COTTON GRADING

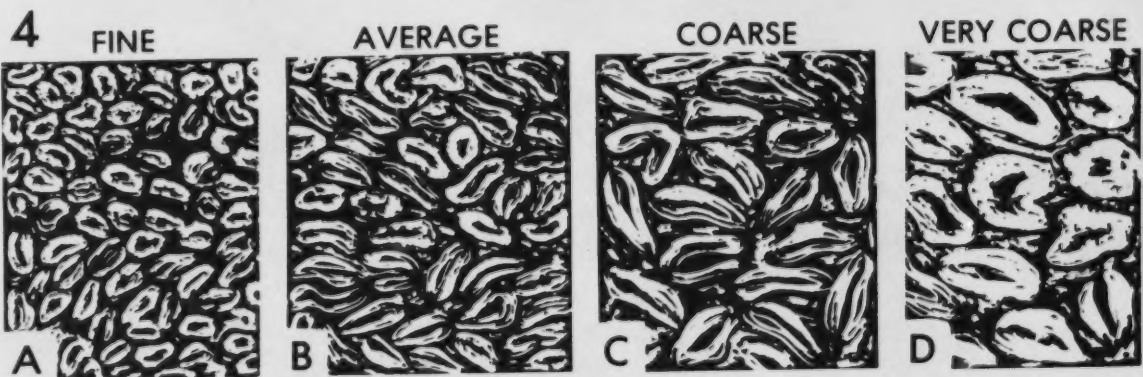
COLOR



STAPLE LENGTHS

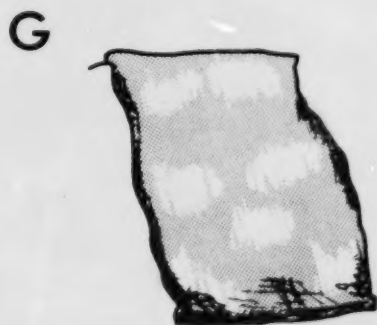
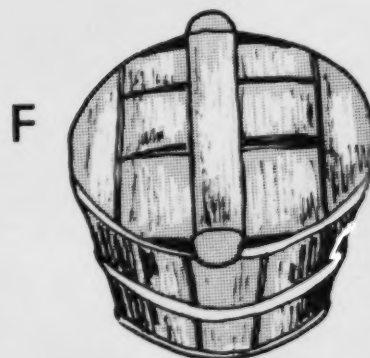
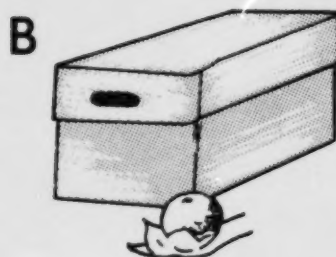
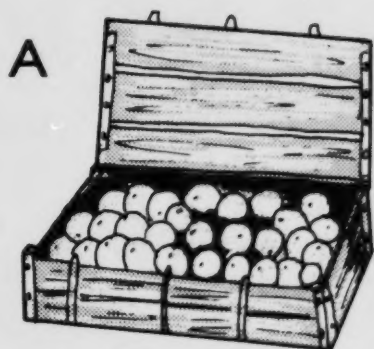


COTTON FIBER STRUCTURE



CROSS SECTION OF COTTON FIBERS

PACKAGING FOR SHIPMENT AND SALE



PLANT SCIENCE

Unit C: Identification and Selection of Fruits, Vegetables, and Ornamental Plants

Topic 1: Classifying and Selecting Fruits and Vegetables

Suggested Procedures and Activities: Two or three samples of fruits and vegetables will be helpful when discussing the topic in class. It is suggested that the samples be used along with the transparencies.

1. Terms Used in Identifying Fruits, Vegetables, and Ornamentals

Pomology is the science and practice of fruit production. Olericulture is the science and practice of vegetable production. A general term that is used to identify the science of fruit, vegetable, and ornamental production is horticulture. It is the part of plant agriculture that deals with garden crops, whereas agronomy refers to field crops, mainly forages, grains, fiber and oil crops.

Transparency No. 1

2. Definition of A Fruit

A fruit is defined as a mature ovary with its enclosed seed or seeds. The common usage of the word "fruit" refers to a crop product that contains a natural ovary which is usually sweet and pulpy. By using this common definition watermelons, grapes, avocados, and apples are fruits. Corn, tomatoes, pea and bean pods, cucumbers, eggplants, peppers, pumpkins, and squash are referred to as "vegetables"; however, these are ovaries or fruits. Fruits are considered a succulent food for man except nuts which are oil fruits. Most fruits are eaten as a snack, salad, or dessert. Most plants that produce fruits are usually classed as woody perennials. In the temperate zone, fruit plants are primarily deciduous; in the tropical zone, fruits are produced from evergreen plants.

3. Types of Fruits

Three different types of tissue are developed from the ripening of the ovary wall (pericarp). The thin outer skin is the exocarp; the fleshy inner tissue is the mesocarp; and the innermost tissue is known as the endocarp. Fruits are classified according to their structure. The number of ovaries and their location is also a factor in classifying fruits. The two major types of fruits are fleshy and dry.

Fleshy fruits are divided into two classes: Drupe and berry.

Drupe - The inner layer of the pericarp is stony; the mesocarp is thin.
Examples: Plum, peach, almond, apricot, and cherry.

Berry - The berry has no stony layers. The interior is fleshy and may have from a few to many seeds. Examples: Tomato, orange, grapefruit, lemon, grape, banana, watermelon, squashes, cucumber, cantaloupes, and pumpkins. These last five fruits are of the pepo family.

Dry fruits are grouped according to the number of seeds. The ovary wall (pericarp) becomes dry at maturity.

Simple fruits have a single ovary. Most flowering plants are included in this group. A simple fruit with a fleshy pericarp is in the berry classification.

Dehiscent fruits usually split open on reaching maturity. Examples: Pea, bean, milkweed, cotton, mustard, scarlet pimpernel, snapdragon, and peppergrass. The fruit may contain many seeds.

Indehiscent fruits do not open. They may have definite seams but they do not split open. Usually only one or two seeds are found in indehiscent fruits. Examples: Corn, wheat, oats, sunflower, ash, acorn, hazelnut, and buttercups.

Multiple fruits contain several ripened ovaries. They are either drupes, berries, or nutlets. Example: Mulberry.

Aggregate fruits are borne from the same flower, forming a cluster. Examples: Blackberries and dewberries.

Accessory fruits consist of a large amount of edible stem and calyx tissue with mature ovaries. The ovaries may be embedded or upon the stem and calyx tissues. Examples: Apple, pears, and strawberries. A pome is an accessory fruit.

Transparency No. 2

Examples of fruit types are:

Fruit Number	Type	Common Name
(1)	drupe	plum
(2)	pome	apple
(3)	berry	tomato
(4)	accessory fruit - achene	strawberry
(5)	pepo	cucumber

(6)	multiple fruit	mulberry
(7)	aggregate fruit	dewberry
(8)	citrus	lemon
(9)	nut	pecan
(10)	caryopsis	corn
(11)	capsule	cotton
(12)	silicle	shepherd's purse
(13)	follicle	milkweed
(14)	legume	bean
(15)	samara	ash
(16)	pyxis	scarlet pimpernel
(17)	siliqua	mustard

4. Definition of A Vegetable and General Classification

If a vegetable is defined as the vegetative part of the plant, then it includes the leaves, stems, roots, and other parts that make up two or more parts of the plant structure. Vegetables can be defined as herbaceous plants that are eaten, either cooked or raw by the individual and animal. All vegetables are classified in the Angiospermae division of plants. This means they have ovules in a carpel or ovary. They are grouped as monocotyledonae (one seed leaf) or dicotyledonae (having two seed leaves).

Transparency No. 3

5. Vegetables Grouped According to Use

- a. Vegetable families that are grown either for their stems, flower parts, or leaves are:

Lily family (liliaceae)

chives, (*allium schoenoprasum*)

asparagus, (*asparagus officinalis* var. *altilis*)

Buckwheat family (polygonaceae)

spinach dock, (*rumex patientia*)

sorrel, (*rumex acetosa*)
 rhubarb, (*rheum raphaniticum*)

Mustard family (cruciferae)

cabbage (*brassica oleracea* var. *capitata*)
 brussels sprouts, (*brassica oleracea* var. *gemmifera*)
 mustard, leaf (*brassica juncea*)
 mustard, southern curled, (*brassica juncea* var. *crispifolia*)
 turnip, seven top, (*brassica rapa* var. *septiceps*)
 sprouting broccoli, (*brassica oleracea* var. *italica*)
 cauliflower, (*brassica oleracea* var. *botrytis*)
 collard, (*brassica oleracea* var. *acephala*)
 pak-choi. Chinese cabbage, (*brassica chinensis*)

Carpetweed family (alzoaceae)

New Zealand spinach (*Tetratonia expansa*)

Valerian family (valerianaceae)

lamb's lettuce or corn - salad, (*valerianella locusta* var. *oliteria*)

Composite or Sunflower family (compositae)

artichoke, (*cynara scolymus*.)
 dandelion, (*taraxacum officinale*)
 lettuce, (*lactuca sativa*)

Ginseng family (araliaceae)

udo, (*aralia cordata*)

Goosefoot family (chenopodiaceae)

beet, (*beta, vulgaris*)
 chard, (*beta, vulgaris* var. *cicla*)
 spinach, prickly-seeded (*spinacia oleracea*)
 spinach, round-seeded (*spinacia oleracea* var. *inermis*)

Parsley family (umbelliferae)

celery, (*apium graveolens* var. *dulce*)
 parsley, (*petroselinum hortense*)

Vegetables Classed According to Seeds and Fruits

Families that are grown for seeds or fruits.

433

Grass family (gramineae)

sweet corn, (*zea mays* var. *rugosa*)

Pulse or pea family (leguminosae)

yardlong bean, (*vigna sesquipedalis*)
 broad bean, (*vicia faba*)
 pea (English pea), (*pisum sativum*)
 peanut (underground fruits), (*arachis hypogaea*)
 lima bean, (*phaseolus limensis*)
 kidney bean (*phaseolus vulgaris*)
 cowpea, (*vigna sinensis*)
 soybean, (*glycine max*)

Mallow family

okra (gumbo), (*hibiscus esculentus*)

Nightshade family (solanaceae)

eggplant, (*solanum melongena*, var. *esculentum*)
 tomato, (*lycopersicon esculentum* var. *commune*)
 pepper bell or sweet, (*capsicum frutescens* var. *grossum*)
 ground cherry, husk tomato, (*physalis pubescens*)

Gourd or melon family (cucurbitaceae)

bush pumpkin, (*cucurbita pepo* var. *meloepo*)
 watermelon, (*citrullus vulgaris*)
 pumpkin, (*cucurbita pepo*)
 squash, (*cucurbita maxima*)
 cucumber, (*cucumis sativus*)
 muskmelon, (*cantaloupe*), (*cucumis melo*.)

Parsley family (umbelliferae) caraway, (*carum carui*)

dill, (*anethum graueolens*)

Martynia, (*proboscidea Louisiana*)

- b. Types of vegetable families that are grown for underground edible parts include:

Nightshade family (solanaceae)

potato, (*solanum tuberosum*)

Yam family (dioscoreaceae)

yam, (true), (*dioscorea batatas*)

Goosefoot family (chenopodiaceae)

beet, (*beta vulgaris*)

Parsley family (umbelliferae)

carrot, (*daucus carota* var. *sativa*)
parsnip, (*pastinaca sativa*)
celeriac, (*apium graveolens* var. *rapaceum*)
hamberg parsley, (*petroselinum hortense* var. *radicosum*)

Mustard family (cruciferae)

horse-radish, (*armoracia rusticana*)
radish, (*raphanus sativus*)
rutabaga, (*brassica napobrassica*)
turnip, (*brassica rapa*)

Morning glory family (convolvulaceae)

sweet potato, yam (erroneously), (*ipomoea batatas*)

Lily family (liliaceae)

garlic, (*allium sativum*)
leek, (*allium porrum*)
onion, (*allium cepa*)
shallot, (*allium ascalonicum*)
Welsh onion, (*allium fistulosum*)

Composite or sunflower family (compositae)

black salsify, (*scorzonera hispanica*)

Transparency No. 3

6. Groups of Vegetable Plants With Common Traits

- a. Vine crops - These crops are grown only during the frost free months. They include squashes, pumpkins, cucumbers, and melons. These crops are known as the melon or gourd family (*cucurbitaceae*).
- b. Solanaceous fruits - The solanaceous vegetable (fruiting vegetable) group includes the tomato, eggplant and peppers. This family is known as nightshade (*solanaceae*) and includes the Irish potato.
- c. Cole crops - Cole crops are winter hardy and found in the mustard or cabbage family (*cruciferae* or *brassicaceae*). These crops include cauliflower, broccoli, kohlrabi, brussels sprouts, kale, and cabbage.

7. Vegetables Classified According to Temperature Adaptation

Vegetables are further classified by their season of growth, either the cool

season or warm season plants. The cool season vegetables are those that can withstand light frost or may endure freezing temperatures. This group may be divided into those that can withstand frost and freezing and those that cannot survive freezing but can continue to grow in very cool weather. This group is referred to in Transparency No. 1 as the half-hardy or hardy group of plants.

Plants that grow and do well in hot weather are called the warm season vegetables. Some of the warm season vegetables can withstand fairly cool weather and there are others that cannot tolerate cool weather.

General classification of vegetables according to their spring frost resistance.

WARM SEASON		COOL SEASON	
<u>Very Tender</u>	<u>Tender</u>	<u>Half-hardy</u>	<u>Hardy</u>
Pumpkin	Snap bean	Potato	Turnip
Pepper	Sweet corn	Lettuce	Rhubarb
Okra	New Zealand	Chinese cabbage	Pea
Squash	spinach	Celery	Radish
Sweet potato	Tomato	Cauliflower	Onion
Watermelon		Carrot	Mustard
Cucumber		Parsnip	Horse-radish
Eggplant		Beet	Cabbage
Lima bean			Brussels sprouts
Muskmelon			Broccoli
			Spinach
			Parsley
			Asparagus

Plants may be divided according to season of growth as well as their use.

Warm season crops:

Crops not transplanted:

snap beans
pumpkins
okra
muskmelons
cucumbers
sweet corn
popcorn
lima beans
squash

Cool season crops:

Perennial crops:

globe artichoke
rhubarb
asparagus

Transplanted fall crops:

cabbage
brussels sprouts
celery
cauliflower
broccoli

Transplanted:
tomatoes
eggplant
peppers

Spring crops:
cabbage
broccoli
celery
head lettuce
leaf lettuce

Crops that withstand some summer
heat:

horse-radish
parsley
potatoes
New Zealand spinach
garlic
onions
leeks
endive
carrots
collards
Swiss chard
kale
beets
parsnip

Crops that reach quick maturity in
spring and fall:

radishes
mustard
leaf lettuce
peas
kohlrabi
spinach

8. Relationship Between Fruit and Vegetable Crops

It is important to know the relationship between different fruit and vegetable crops. The growth habits of many types of fruits are similar as is the case of many vegetable crops. Cultural practices such as cultivation, fertilization, and insect and disease control methods may be the same or different among the various types of fruits and vegetables. However, selection is not made according to all of these characteristics of the many types of plants. The selection according to insect and disease resistant varieties is important if control practices are in doubt. Desirable characteristics that both fruit and vegetables must have are:

Adaptable to climatic conditions
Adaptable to soil conditions
Adaptable to local market conditions

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1. Bailey, L. H., Manual of Cultivated Plants, The Macmillan Company, Toronto, Canada, 1969.
2. Janick, Jules, and Others, Plant Science an Introduction to World Crops, W. H. Freeman and Company, San Francisco, California, 1974.
3. McCollum, J. P., Producing Vegetable Crops, The Interstate Printers and Publishers, Inc., Danville, Illinois, 1975.

VEGETABLES WITH SEEDS ARE FRUITS!



AVOCADO



EGGPLANT



BEANS



PEPPERS



CORN



PUMPKINS



CUCUMBER

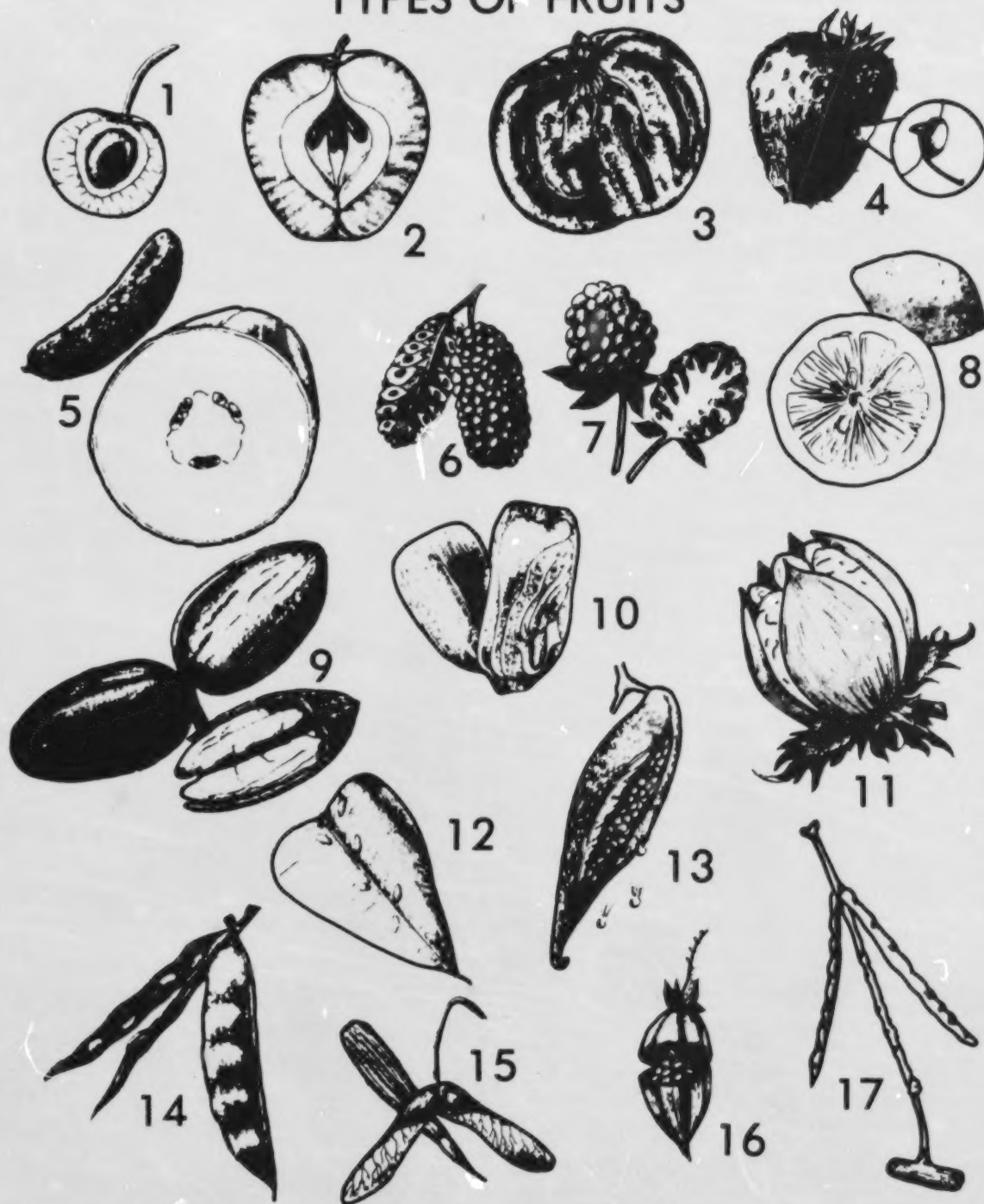


SQUASH

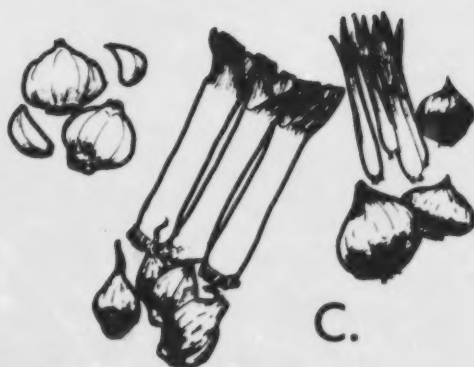


TOMATOES

TYPES OF FRUITS



TYPES OF FRUITS AND VEGETABLES



PLANT SCIENCE

Unit C: Identification and Selection of Fruits, Vegetables, and Ornamental Plants

Topic 2: Classifying and Selecting Ornamental Plants

Suggested Procedures and Activities: The use of filmstrips, slide films and live specimens (ornamental plants) may be used during the class discussion.

1. Different Bases for Plant Classification

Since primitive times the human being has categorized the surroundings as to living or nonliving, and in the case of living organisms, plant and animal. Ancient people were interested in the practical aspects of plants. They recognized plants that provided food, shelter, clothing, and fuel. However, during medieval times, some studies of plants were recorded in books called Herbals. Modern botany foundations began to be established during the seventeenth and eighteenth centuries.

Plant classification and relationship (taxonomy) and plant structure (morphology) were the first types of botany studies. These types of studies did not require technical equipment and supplies.

Plants can be classified on the basis of several different characteristics. Some of the most common ones are as follows:

Transparencies Nos. 1, 2, 3, 4, and 5

Useful or Harmful - Early man first divided plants according to those that could be used for food or shelter, and those plants that could not be used by man or animal. The latter group is usually called "weeds".

Structural Form Characteristics - Plants may be classified as woody or herbaceous (succulent). Herbaceous seed plants with self-supporting stems are called herbs, while those that require support are called vines. Self-supporting woody plants are either trees or shrubs, the shrubs being characterized by having several upright stems while the trees usually have only one upright stem. Woody plants that require support for upright growth are called lianas.

Deciduous and Non-Deciduous - Plants that completely shed their leaves during the winter are known as deciduous plants. Some examples of deciduous trees are most oaks, willow, hackberry, Chinaberry, redbud, and mimosa. Non-deciduous (evergreens) keep their leaves the entire year. Some examples are juniper, pine, spruce and live oak.

Life Span - Plants are classified on the basis of their life span.

Annuals are plants that normally complete their life cycle in one growing season. Some examples are peas, gourds, petunias, some phlox, zinnias, and snapdragons.

Biennials are plants that normally complete their life cycle in two growing seasons. Some examples are hollyhock, sweet william, and evening primrose.

Perennials are plants that grow from year to year and may take several seasons to reach maturity. The perennial does not die after flowering as do the annuals. Examples are oaks, pines, junipers, bulb plants, some vine plants, ferns, shrubs, tulips, and chrysanthemums.

Tender and Hardy - Plants may be classified as tender, if they cannot withstand low temperatures. They are referred to as cool season or warm season, depending upon the time of year during which they grow and bloom.

Environmental Needs - Other classifications may be made on the basis of site preference such as desert or aquatic, sunny or shady, and acid or alkaline. Examples: Blackjack oak grows best in poor dry sites and swamp chestnut oak of East Texas grows best in wet soil.

Morphological Characteristics - The most significant criteria used in plant classification are the structures of plant parts. This includes the root system, stems, leaves, flowers, fruit, and color of the plant.

Method of Reproduction - This is an important factor used in classifying plants. Many parts of the plant may be changed by environmental conditions, but the flower, fruit, and seed characteristics remain almost constant. Ornamental plants reproduce by sexual and asexual reproduction.

Another Criterion Used to Help Classify a Plant - Not all plants obtain food in the same way. For example, leguminous plants take nitrogen from the air and store it in the soil, whereas non-leguminous plants do not have this type of nitrogen-storing characteristic.

2. Major Divisions of Ornamental Plants

Ornamental plants are divided into two major classes, floricultural plants and nursery plants. Floricultural plants are generally herbaceous (succulent). They are grown for their blossoms and colorful leaves.

Nursery plants usually include woody and herbaceous perennials. They are grown

for landscaping purposes and can be classified according to their growth habits.

Five of the major kinds of nursery plants are lawn or turf, ground covers, shrubs, vines, and trees. These different kinds of plants will be identified by genus and species near the end of this topic.

There are several nursery plants that are grown for their food-producing qualities. For example, nut producing trees such as the pecan can be grown as ornamentals if the shade-producing characteristic is utilized for that purpose. If a grape vine is grown to cover an overhead trellis, it is recognized as an ornamental, but if it is grown to produce a small berry, it is known as a fruit producing vine.

Transparency No. 6

3. Scientific Classification

Scientific classification is a method of dividing organisms first into small groups, on the basis of their similarities and differences. The first distinction is at the kingdom level. The taxonomic categories for climbing rose in the plant kingdom are:

Kingdom - Plant
Division (Phylum) - Spermatophyta

Class - Angiospermae	
Subclass - Dicotyledoneae	Major Taxa
Order - Rosales	
Family - Rosaceae	

Genus - Rosa	
Species - setigera	Minor Taxa
Variety - tomentosa	

An example of common names used in the plant kingdom is as follows:

Spermatophyta - Seed plants
Angiospermae - Flowering plants
Dicotyledoneae - Dicots
Rosales - Rose order
Rosaceae - Rose family
Rosa - Rose
Setigera - Climbing rose
Tomentosa - A special climbing rose

These common names are listed above in the major and minor taxa. All categories from genus and below are listed in the minor taxa.

The angiosperm is the most important class of plants. There are over a quarter million species of angiosperms throughout the world. They are divided into two major classes, the monocotyledonae (monocots) and dicotyledonae (dicots). Angiosperms are usually considered broad leaved plants with seed enclosed in an ovary. They are the main source of food, clothing, shelter, and many other raw materials. Most of the flowering ornamental plants are in this class.

The second plant class of the division spermatophyta, the gymnosperms, include about 700 species of plants which are primarily evergreen trees. They provide lumber, lumber by-products and ornamental plants.

Another vascular plant division is the pteridophyta or fern plants. Many fern species are considered ornamental plants.

As one goes through the classification of organisms, the categories become more exclusive, and the organisms become more and more similar. Their differences have a tendency to be less obvious and more technical, but all plants have characteristics that cause them to be grouped in a certain order, family, genus, and species. For example, a common grass, bermuda grass, is placed in the order graminales and family gramineae because it has the following characteristics:

Its flowers are hidden in the chaffy bracts (leaf surrounding the flower) or reduced leaves.

Its fruit is either an achene or caryopsis (a small dry one-seeded fruit).

Its flower is subtended by a lemma (lower bract) which closes both the flower and the palea (the upper bract).

The whole spikelet is subtended by two bractlets which do not enclose individual flowers.

Its stems are hollow and circular in cross sections.

Its leaf sheaths are not coalescent by the margins.

The gramineae family is made up of several genera. Genera are groups in which plants have several morphological (structural) similarities. They are further subdivided into species or groups that have many more morphological similarities, than do the members of a genus. This family is considered more important as food plants because of their grain and forage production characteristics.

4. Factors That Affect Selection of Ornamental Plants

Naturally, climatic condition is a very important factor to consider when select-

ing plants. This involves temperature, rainfall, and wind.

Temperature - First of all, the United States is divided into several temperature regions. Texas alone has five different temperature zones with a minimum temperature range from a minus 10° F to a maximum temperature in each zone of over 100° F. These minimum and maximum temperatures must be taken into consideration when ornamental plants are being selected. For example, tender plants must have protection during cold periods; therefore, one would not want to select a plant that requires extra care for planting during the winter months. Plants vary in their adaptation to the variation of temperature.

Rainfall - There are several rainfall regions in the United States and Texas. Some parts of East Texas receive over 40 inches of rainfall annually, whereas other parts receive below 15 inches annually. A plant that requires a high amount of water in an area of low rainfall must be furnished water artificially, and if they are grown around homes they are more often over-watered than under-watered. However, different plants vary in the amount of water needed for growth and maintenance.

Wind - This is another climatic factor to consider when selecting plants; that is, if high wind velocity is a problem in the area. Wind combined with either soil movement or excessive moisture can be a serious problem. Usually tall plants with a tap root system will withstand more wind than plants with a fibrous root system. In most areas wind is not considered a problem for outside ornamental plant production.

Another important factor is soil conditions.

Soil pH - The pH of a soil is the degree of acidity or alkalinity on a scale from 0 to 14. A neutral soil is 7. Any number above 7 is alkaline and below 7 is acid. Some plants require acid soils, whereas others require alkaline soils. The pH may be affected by soil depth and moisture in the soil. For example, a soil that is continually moist or wet is likely to be acid. This is the reason that good drainage is important. Some grass plants grow best in a neutral soil. Instead of trying to locate a grass plant that will grow in an acid soil, it is considered best to lime the soil to make it more neutral.

Soil Depth - The top layer of a soil supplies nutrients for plants in the development stages. The ideal soil must contain the proper amount of moisture, all the essential elements, adequate organic matter and proper amounts of air. The subsoil which is below the main root system holds the moisture so that it can be used in the vacancy of the top soil.

Soil Physical Properties - In order for a soil to be in good physical condition for plant growth and maintenance, the solid particles must be in the right

proportions. The particles must be open in order to permit moisture to enter, yet close enough to retain the moisture and open enough to be well aerated so plant roots can receive adequate oxygen. Two terms that are used frequently to describe physical properties are as follows:

Soil Texture - This term refers to the amount of sand, silt, and clay in a soil. For example, a soil containing 65 percent sand, 25 percent silt, and 10 percent clay is classed as sandy loam. If a soil contains 25 percent sand, 65 percent silt, and 10 percent clay, it is classed as a silt loam.

Soil Structure - This term is used to identify how the particles are grouped together to form aggregates. The property of infiltration of water is greatly influenced by structure. Granular and single grain soils permit rapid infiltration of water, blocky and prismatic soils take in moisture moderately fast, and massive and platy soils (particles stick together) take in water very slowly.

All soil factors must be considered when selecting plants. Even though most plants will do better on rich soils, some will tolerate soils that are classed infertile. The texture and structure of a soil are also factors to consider when selecting plants. For example, there are turf grasses that grow more rapidly on loose or granular soils than on tight, clay type soils. Yet, there are grasses adapted to the clay loam soils.

An important factor that is overlooked many times when selecting ornamental plants is light requirements. Some plants require full sunlight for maximum growth, while others require varying amounts of shade and sun. Plants that require full sunlight should not be selected for planting in an area of filtered light or partial shade. Plants that require partial shade should be planted where the light is filtered, such as an area under trees, eaves of buildings, under light filtering material, and in greenhouses.

Transparency No. 7

Growth form affects selection. A sprawling type juniper does not grow into an up-right tree. Also, a spreading, long-limbed tree such as a mimosa should not be planted near a permanent flower bed or too close to a wall or similar structure.

Proper landscaping procedures should be followed when placing short (dwarf), medium, and tall plants. The size of plants is certainly a factor in selecting shrubs or in selecting flowering plants (annuals and perennials) for flower beds. Tall plants are planted near walls or at the back of shorter plants. In patio or center flower gardens, tall plants are planted in the center of the arrangement in order not to hide the shorter plants.

Transparency No. 8

Rate of growth is a factor in selecting shade trees. Many homesites are treeless. It might be best if a few fast-growing species are planted in addition to the "favorite" trees which may be slow growers.

Ornamental plants may be selected according to blooming dates. Some landscapes have beautiful flowers during one season of the year, but are relatively barren during the remainder of the year. The approximate blooming dates should be checked in order to utilize several different varieties that will produce blooming plants in the garden year round.

Another very important factor that must be observed when selecting plants is the amount and intensity of care that certain species require. Many good ornamental plants are relatively simple and easy to care for, while others require more complex and intensive care. One must allow for considerable time and money to be devoted to the maintenance of plants whose size or growth form do not fit the location and use for which they were planted. It is usually better to select the right plant for the job than to have to force the wrong plant into an acceptable shape so it will fit the use desired.

Trees may be selected for their unusual bark color. Some trees are especially attractive during the winter months. Trees with attractive bark are: Hackberry, magnolia, sycamore, cottonwood, white oak, white poplar, and yellowwood. Some trees are selected according to the color of foliage at certain seasons. For example, purple foliage appears on white ash and white oak; red leaves appear on dogwood; sassafras has orange leaves; and yellow foliage may appear on hickory, oak, poplar, linden, elm, ash, and redbud. Most trees are expected to live between 50 and 100 years; therefore, useful life is not a factor in selecting a tree.

The undesirable characteristics in selecting a tree are:

- a. The American elm is susceptible to the Dutch elm disease.
- b. Pecan and thornless honeylocust are subject to attack by certain types of webworms.
- c. Mulberry and female ginkgo are considered garbage trees in many localities due to the fruit they produce.
- d. Cottonwood sheds leaves the entire year in semiarid regions.
- e. Sweetgum fruits-gum balls-are a nuisance in lawns.
- f. Elm, willow, and poplar are notorious sewer cloggers.
- g. Poplars and mimosa produce seed that sprout in the lawn and flower bed.

The problem of selecting shrubs equals that of selecting desirable trees. Most shrubs are selected for the following reasons:

- To accent the lines of a building.
- To beautify an area with colorful flowers, berries, or foliage.
- To screen a particular view.
- To serve as borders for drives, walks, and boundary lines.

There are several factors that should be considered when selecting shrubs. Some of the most important factors are: The size of plant desired; soil conditions; type of foliage, color and condition all seasons; maintenance blends with surroundings. Most shrubs can use some shade.

The following plants vary in their requirements for light, some needing complete shade and others needing full sunlight.

- American Arbor-Vitae - This shrub will tolerate some shade.
- Yews - It will tolerate partial to full shade.
- Japanese aucuba - This plant does best in light to full shade.
- Arrowwood - This plant will grow in any kind of shade.
- Japanese andromeda - This particular plant requires only light shade.
- Camellia - Camellia is a very popular plant for planting in light to open shade.
- Dogwood - Gray dogwood should be planted in light to half shade.
- Japanese holly - This plant will tolerate dense shade.
- English Ivy, Mountain-laurel, periwinkle, and rhododendron require open shade.

Transparency No. 9

5. Recommended Plant Areas for Certain Zones in the United States and Texas

The plant zones defined on transparency No. 9 are based on soil types, temperature, rainfall, and altitude. This does not necessarily mean that other types of plants will not thrive in these areas under special care.

Listed in the following chart are several plants that seem to thrive in zones 0, 1, 2, 3, 4, 5, and 6:

Most of the major grasses in each group of the two major groups consist of several well known varieties. For example, bermuda varieties are common, tifway, tif-green, ormond, U-3, T-35-A, tiffine, and sunturf.

The two groups of grasses are listed as follows:

Cool-season
Bent grasses

Subtropical
Zoysia grasses

Fine fescues
 Blue grasses
 Rye grasses (one annual)
 Redtop
 Coarse fescue

St. Augustine grasses
 Bermuda grasses

Ground covers - There are more than one hundred different types of ground cover plants excluding grasses. Most ground covers are either herbaceous or woody perennials. They are similar to grasses, in that temperature and rainfall may greatly affect the adaptation of the plant. The majority of ground covers are considered hardy plants that will withstand sub-zero temperatures. However, there are a few plants which require temperatures above ten degrees Fahrenheit. Some ground cover plants that are commonly found in most states are:

Achillea Tomentosa - Woolly Yarrow
Ajuga Reptans - Carpet Bugle
Asperula Odorata - Sweet Woodruff
Bergenia Crassifolia - Winter Blooming Bergenia
Calluna Vulgaris - Scotch Heather
Campanula Carpatica - Tussock Bellflower
Cerastium Tomentosum - Snow-in-Summer
Ceratostigma Plumbaginoides - Blue Leadwort
Duchesnea Indica - Indian Mock Strawberry
Euonymus Fortunei - Winter Creeper
Hedera Helix - English Ivy
Hypericum Calycinum - Aaron's Beard
Juniperus Chinensis 'San Jose' - San Jose Juniper
Juniperus Horizontalis - Waukegan Juniper
Lantana Montevicensis - Trailing Lantana
Lonicera Japonica - Halls Japanese Honeysuckle
Mahonia Repens - Creeping Mahonia
Myosotis Scorpioides - True Forget-me-not
Nepeta Hederacea - Ground Ivy
Ophiopogon Japonicus - Mondo Grass
Phlox Subulata - Ground Pink
Pyracantha 'Santa Cruz' - Pyracantha
Saxifraga Sarmentosa - Yerba Buena
Trachelospermum Jasminoides - Star Jasmine
Vinca Major - Common Periwinkle

Shrubs - Many of the shrubs are considered to be deciduous (lose their leaves annually). However, some shrubs, such as junipers, are evergreens. There are thousands of ornamental plants classed as shrubs. They are similar to all

other plants in that they are adapted to certain areas due to certain limiting factors such as temperature, rainfall, and soil conditions. The average minimum temperature is illustrated by zones on the map.

Plants may not grow normally if planted in zones where the temperature drops below the minimum recommended for the plant. This does not necessarily eliminate the plant's being grown in another zone at warmer temperatures, especially if moisture conditions are altered. Some of the more common shrubs are:

<i>Abelia grandiflora</i> - Glossy Abelia	(evergreen, Zone 1) Used as a larger hedge, screen, border, or accent plant.
<i>Aucuba japonica</i> - Japanese Aucuba	(evergreen, Zone 3) Used as an accent or, if large, as a background plant.
<i>Berberis thunbergii</i> - Japanese Barberry	(deciduous, Zone 0) Used as a hedge or accent plant.
<i>Buxus sempervirens</i> - Common Boxwood	(evergreen, Zone 1) Used as specimens, screens, or accents.
<i>Cotoneaster horizontalis</i> - Rockspray Cotoneaster	(deciduous semievergreen, Zone 0) Effective in rock gardens and as a filler plant.
<i>Euonymus japonicus</i> - Evergreen Euonymus	(evergreen, Zone 4) Used as a specimen shrub, sheared hedge, or undercover.
<i>Ilex cornuta</i> Burfordii - Burford Chinese Holly	(evergreen, Zone 3) Used as an informal hedge and as a specimen plant.
<i>Juniperus Chinese Pfitzeriana</i> - Pfitzer Juniper	(evergreen, Zone 0) Used as a border ground cover or base plant.
<i>Lagerstroemia indica</i> - Crape Myrtle	(deciduous, Zone 3) Used as deciduous screen or in place tree will not fit.
<i>Ligustrum lucidum</i> - Glossy Privet	(waxleaf, evergreen, Zone 3) Used as a specimen, screen or low windbreak hedge.
<i>Mandina domestica</i> - Heavenly Bamboo	(evergreen, Zone 3) Used as a corner or foundation planting and as a background or specimen shrub.
<i>Pittosporum tobira</i> - Green Pittosporum	(evergreen, Zone 4) Used as a hedge, barrier, screen, or accent plant.
<i>Pyracantha coccinea</i> - Scarlet Firethorn	(evergreen, Zone 2) Used as a colorful specimen plant or as an espalier at the wall.
<i>Raphiolepis indica</i> - Indian Hawthorn	(evergreen, Zone 3) Used in planter boxes and as a small hedge.
<i>Thuja orientalis</i> - Oriental Arborvitae	(evergreen, Zone 2) Used in areas requiring a large shrub.
<i>Viburnum suspensum</i> - Sandangus Viburnum	(evergreen, Zone 5) Used as a rugged hedge tolerating most adverse conditions.

Even though these shrubs are listed for a certain zone, most are found in that zone and south throughout the other zones.

Vines - Are both herbaceous and woody. They are also classed as evergreens, semievergreens, and deciduous plants. Vines are similar to shrubs and other ornamental plants, in that they are adapted to certain areas (zones) and when grown in the northern states they may appear to be completely deciduous. Yet, in the South they are evergreens. Some of the more common vines are:

<i>Ampelopsis arborea</i> - Peppervine	(semievergreen, Zone 3) Used mainly for ground cover and clinging to stone walls.
<i>Bignonia capreolata</i> - Crossvine	(evergreen, Zone 2) Used as a clinging vine.
<i>Boussingaultia baselloides</i> - Madeira Vine	(evergreen, Zone 5) Used as a clinging vine.
<i>Campsis grandiflora</i> - Trumpet Vine	(deciduous, Zone 3) Used as a flowering and climbing vine.
<i>Cissus incisa</i> - Marine-ivy	(semievergreen, Zone 4) Used as a Clinging vine.
<i>Clematis armandii</i> - Armand Clematis	(evergreen, Zone 3) Used to produce flowers in shaded areas. Most species have colorful fruit.
<i>Cobaea scandens</i> - Cup and Saucer Vine	(evergreen, Zone 5) Used for its beautiful and long lasting spring and summer flowers.
<i>Distictis lactiflora</i> - Vanilla Distictus	(evergreen, Zone 5) Used to produce beautiful flowers.
<i>Ficus pumila</i> - Creeping Fig	(evergreen, Zone 5) Used to cover walls.
<i>Gelsemium sempervirens</i> - Carolina Yellow Jessamine	(evergreen, Zone 4) Used as a climbing vine and as a ground cover.
<i>Hedera helix</i> - English Ivy	(evergreen, Zone 2) Used to cover walls and to form hedges and ground covers.
<i>Jasminum Mesnyi</i> - Primrose Jasmine	(semievergreen, Zone 5) Used as a flowering vine and ground cover.
<i>Jasminum officinale</i> - Common White Jasmine	(semievergreen, Zone 3) Used as a semiclimbing shrub with fragrant flowers.
<i>Lonicera hildebrandiana</i> - Giant Honeysuckle	(evergreen, Zone 5) Used as a flowering vine and ground cover.
<i>Muehlenbeckia complexa</i> - Wirevine	(evergreen, Zone 2) Used to cover rocks, fences, and walls.
<i>Parthenocissus heptaphylla</i> - Sevenleaf Creeper	(deciduous, Zone 3) Used as a climbing vine on stone walls and trellises.
<i>Passiflora caerulea</i> - Bluecrown Passion-flower	(evergreen, Zone 4) Used as ground cover, for fragrant flowers and climbing vine.

Phaedranthus buccinatorius - Blood Trumpet-vine	(evergreen, Zone 5) Used for screening purposes - covers large area in short time.
Schisandra propinqua - Himalayan Magnoliavine	(evergreen, Zone 4) Used as many other vines - twining and cover.
Smilax megalantha - Coral Greenbrier	(evergreen, Zone 3) Used as a climbing vine. Has lustrous foliage.
Trachelospermum asiaticum - Yellow Star-jasmine	(evergreen, Zone 3) Used as a twining vine with fragrant flowers - makes screen.
Wisteria macrostachya - Kentucky Wisteria	(deciduous, Zone 2) Used as late blooming twining vine, usually planted to cover porches and arbors.

There are about 1,100 species of native trees found in the United States and more than half of these are in the southern states. Texas alone has some 200 species that are native plants. Many exotic species have been added during the last century.

Trees are identified by several general terms. Some of the more common terms are:

Cone-bearing or needle-bearing trees - These trees are generally classed as softwood trees and are also known as conifers. The term non-deciduous (evergreens) is used to identify this group of trees.

Broad-leaf or hardwood trees are usually considered deciduous (shed their leaves in autumn). However, live oak, southern magnolia, and American holly do not shed.

Trees are the same as other plants in that they prosper better in certain areas of the state due to ideal temperature, rainfall, altitude, and soil type conditions. The hardiness zone map used for shrubs may also be used to determine where certain trees grow best in the state. Some of the more common ornamental tree type plants are listed below by genus, species, and common name. The area in which they may be better adapted and the uses of most of the trees are also listed. These plants are as follows:

Albizia julibrissin - Mimosa or Silktree	(deciduous, Zone 3) Used as a specimen tree, yet is considered a trashy tree.
Carya illinoensis - Pecan	(deciduous, Zone 1 south) Used as shade trees and nut production.
Cedrus deodara - Deodar Cedar	(evergreen, Zone 3) Used as a large specimen tree.
Pinus taeda - Loblolly Pine	(evergreen, East Texas) Used as a specimen tree and building material.

<i>Taxodium distichum</i> - Baldcypress	(deciduous, East Texas) Used as a specimen tree and building material.
<i>Fraxinus velutina</i> - Arizona Ash	(deciduous, Zone 5) Used as a street tree or shade tree.
<i>Cupressus empervirens</i> - Columnar Italian Cypress	(evergreen, Zone 3) Used along boulevards or to frame views where a strong vertical line is needed.
<i>Gleditsia triacanthos inermis</i> - Thornless Honeylocust	(deciduous, Zone 0 south) Used as a tall barrier hedge when young.
<i>Magnolia grandiflora</i> - Southern Magnolia	(evergreen, Zone 3 east) Used as a large specimen tree in areas with adequate soil, moisture, and space.
<i>Liquidambar styraciflua</i> - Sweetgum	(deciduous, Zone 5 south and east) Used as a shade and specimen tree.
<i>Malus species cv</i> - Flowering Crabapple	(deciduous, Zone 1 south) Used as a small flowering specimen tree.
<i>Pistacia chinensis</i> - Chinese Pistache	(deciduous, Zone 5) Used as a shade tree and colorful plant in fall.
<i>Platanus occidentalis</i> - American Plane Tree (Sycamore)	(deciduous, Zone 3 south) Used as a shade tree, street tree, or specimen tree in areas with ample space.
<i>Podocarpus macrophylla</i> - Yew Podocarpus	(evergreen, Zone 3 south) Used as a small tree, hedge, or even shrub.
<i>Populus deltoides</i> - Cottonwood	(deciduous, Zone 3 south) Used as a specimen and street tree.
<i>Prunus caroliniana</i> - Carolina Cherry Laurel	(evergreen, Zone 4 south) Used as a specimen tree or as a natural hedge.
<i>Quercus virginiana</i> - Live Oak	(evergreen, Zone 3 south) Used as a spectacular shade tree.
<i>Quercus falcata</i> - Spanish or Southern Red Oak	(deciduous, Zone 3 south) Used for landscape planting where large trees are needed.
<i>Quercus Nigra</i> - Water Oak	(deciduous, Zone 3 south) Used as a shade and street tree.
<i>Quercus palustris</i> - Pin Oak	(deciduous, Zone 1 south) Used as a specimen and lawn tree.
<i>Quercus shumardii</i> - Shumard Oak	(deciduous, Zone 1 south) Used for large shade or specimen tree.
<i>Ulmus americana</i> - American Elm	(deciduous, Zone 0 south) Used as a large shade tree and lawn specimen.
<i>Ulmus parvifolia</i> - Chinese Elm	(deciduous, Zone 5 south) Used as an outstanding tree for landscape, permanent screen, and windbreak plant.

<i>Sapium sebiferum</i> - Chinese Tallow	(deciduous, Zone 5) Used for landscaping in lawn areas.
<i>Morus rubra</i> - Red or American Mulberry	(deciduous, Zone 0 south) Used for shade and specimen tree.
<i>Celtis occidentalis</i> - Common Hackberry	(deciduous, Zone 0 south) Used for street and lawn planting.
<i>Cornus florida</i> - Flowering Dogwood	(deciduous, Zone 0 south) Used as a small plant to add color during blooming stage.
<i>Fraxinus velutina galbra</i> - Modesto Ash	(deciduous, Zone 3) Used as a street and lawn tree.

References:

1. Crockett, James Underwood and The Editors of Time - Life Books, Landscape Gardening, Time - Life Books, New York, 1971.
2. Crockett, James Underwood and The Editors of Time - Life Books, Lawns and Ground Covers, Time - Life Books, New York, 1971.
3. Crockett, James Underwood and The Editors of Time - Life Books, Trees, Time - Life Books, New York, 1971.
4. Fuller, Harry J. and Zone B. Carothers, The Plant World, Holt, Rinehart and Winston, Inc., New York, 1967.
5. Janick, Jules and Others, Plant Science an Introduction to World Crops, W. H. Freeman and Company, San Francisco, California, 1974.

CHARACTERISTICS USED TO CLASSIFY ORNAMENTALS

USEFULNESS

STRUCTURAL FORM

DECIDUOUS (Shed Leaves)
OR
NON-DECIDUOUS (Evergreen)

LIFE SPAN (a. Annual, b. Biennial, c. Perennial)

TENDER OR HARDY

ENVIRONMENTAL NEEDS

MORPHOLOGICAL

METHOD OF REPRODUCTION

NUTRITIONAL NEEDS

SITE CHARACTERISTICS (ANNUALS)

SUNNY

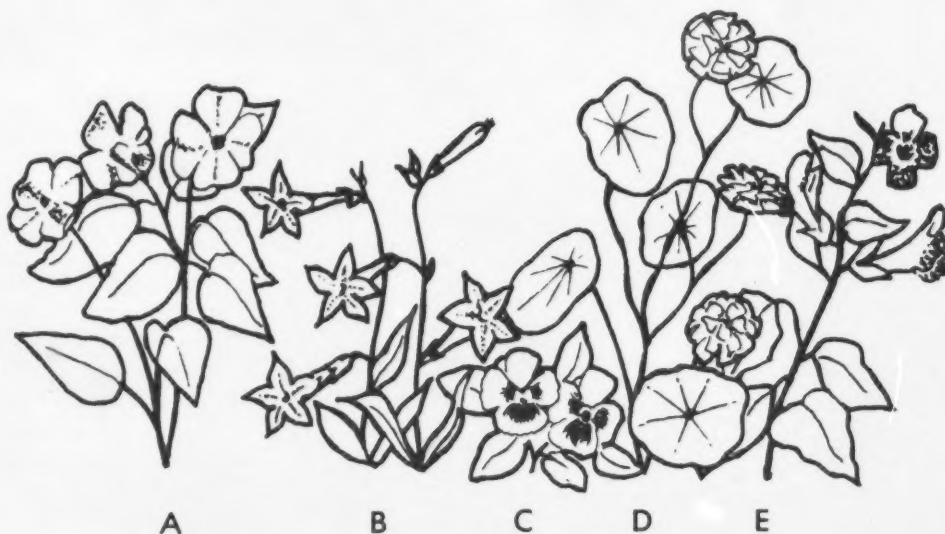


AFRICAN DAISY
AGERATUM —F
ALYSSUM
ASTER —E
CALENDULA
CANDYTUFT —B
CELOSIA
CLEOME
COSMOS —C
DAHLIA
HOLLYHOCK —A

LARKSPUR —H
PANSY —K
PHLOX
POPPY
PORTULACA —I
SAGE
SNAPDRAGON
STOCK
SWEET PEA —D
VERBENA —J
ZINNIA —G

SITE CHARACTERISTICS (ANNUALS)

SHADE OR PART SHADE



CLEOME
IMPATIENS —A
NASTURTIIUM —D
NICOTIANA —B
TORENIA —E
PANSY —C

SITE CHARACTERISTICS (PERENNIALS)

SUNNY



SEED

ACHILLIA —A
 ALYSSUM —O
 ASTER —B
 CHRYSANTHEMUM —N
 COREOPSIS —C
 DAYLILY —M
 DELPHINIUM
 DIANTHUS
 ENGLISH DAISY
 GAILLARDIA —I
 GERBERA —F
 MICHAELMAS DAISY
 GERANIUM
 PENSTEMON —L
 PHLOX
 SHASTA DAISY

BULBS

CANNA
 CALLA LILY —E
 CROCUS —J
 DAHLIA —D
 GLADIOLUS
 HYACINTH
 IRIS —H
 LILY —G
 NARCISSUS
 RANUNCULUS —K
 TULIP

SITE CHARACTERISTICS (PERENNIALS)

SHADE OR PART SHADE



ACHIMENES —A

HOSTA

BEGONIA —D

JAPANESE ANEMONE —C

COLUMBINE —F

PRIMROSE

CYCLAMEN —H

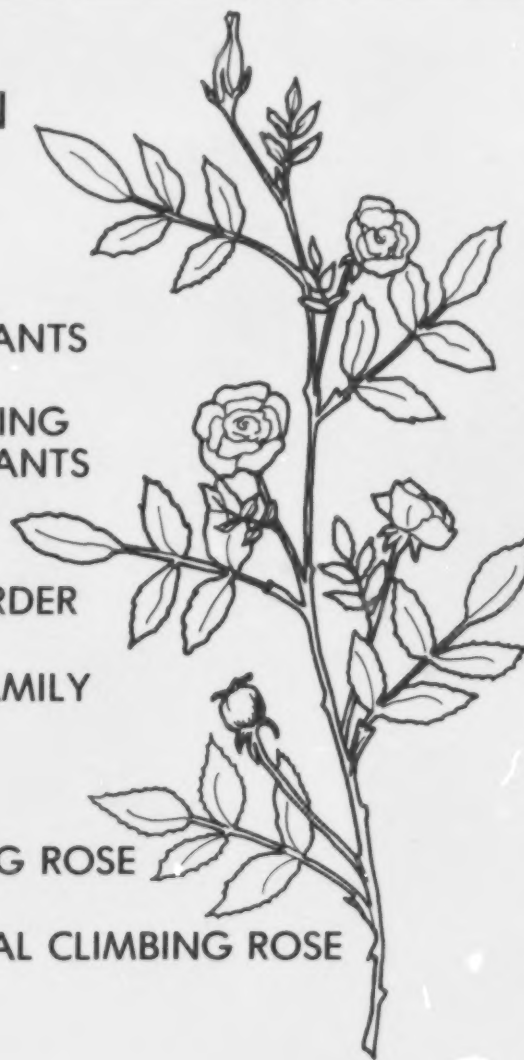
SPIDER LILY —G

GLOXINIA —B

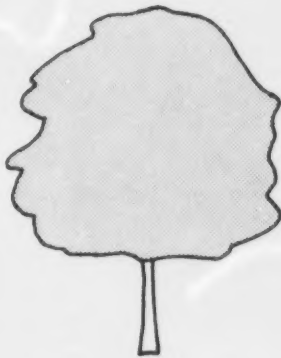
THALICTRUM —E

THE TAXONOMIC CLASSIFICATION OF A ROSE

KINGDOM	PLANTAE	PLANTS
PHYLUM	SPERMATOPHYTA	SEED PLANTS
CLASS	ANGIOSPERMAE	FLOWERING PLANTS
SUBCLASS	DICOTYLEDONAE	DICOTS
ORDER	ROSALES	ROSE ORDER
FAMILY	ROSACEAE	ROSE FAMILY
GENUS	ROSA	ROSE
SPECIES	SETIGERA	CLIMBING ROSE
VARIETY	TOMENTOSA	A SPECIAL CLIMBING ROSE



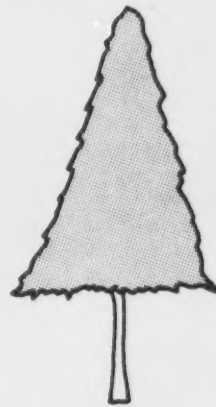
TREE FORMS



ROUNDED



COLUMNAR



PYRIMIDAL



WEEPING



OVATE



OBLONG



OBOVATE



LANCEOLATE



TRUNCATE



BROAD-OVATE



PICTURESQUE



GLOBOSE

SPEED OF GROWTH

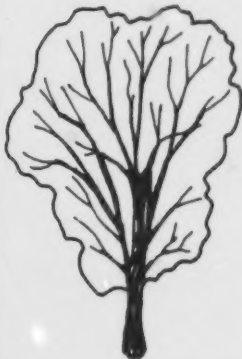
FAST



Chinaberry



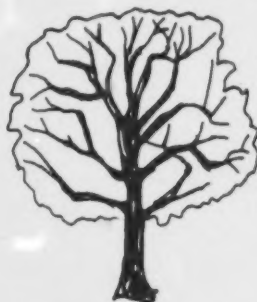
Chinese Tallow



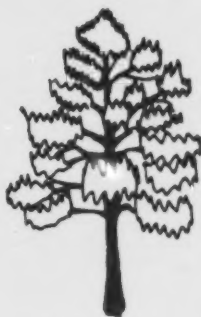
Cottonwood



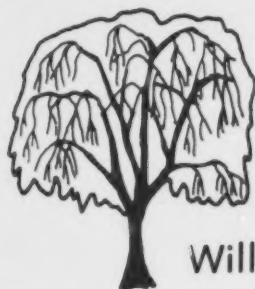
Mimosa



Sycamore

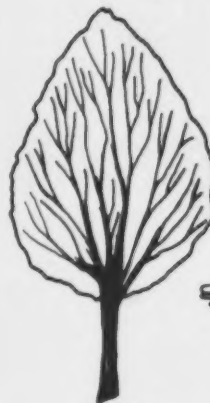


Pines



Willow

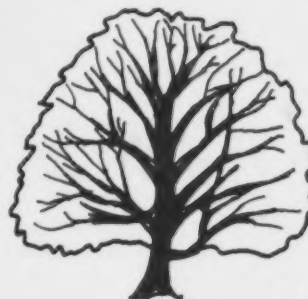
SLOW



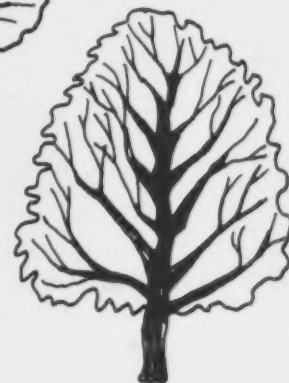
Ash



Juniper



Oak

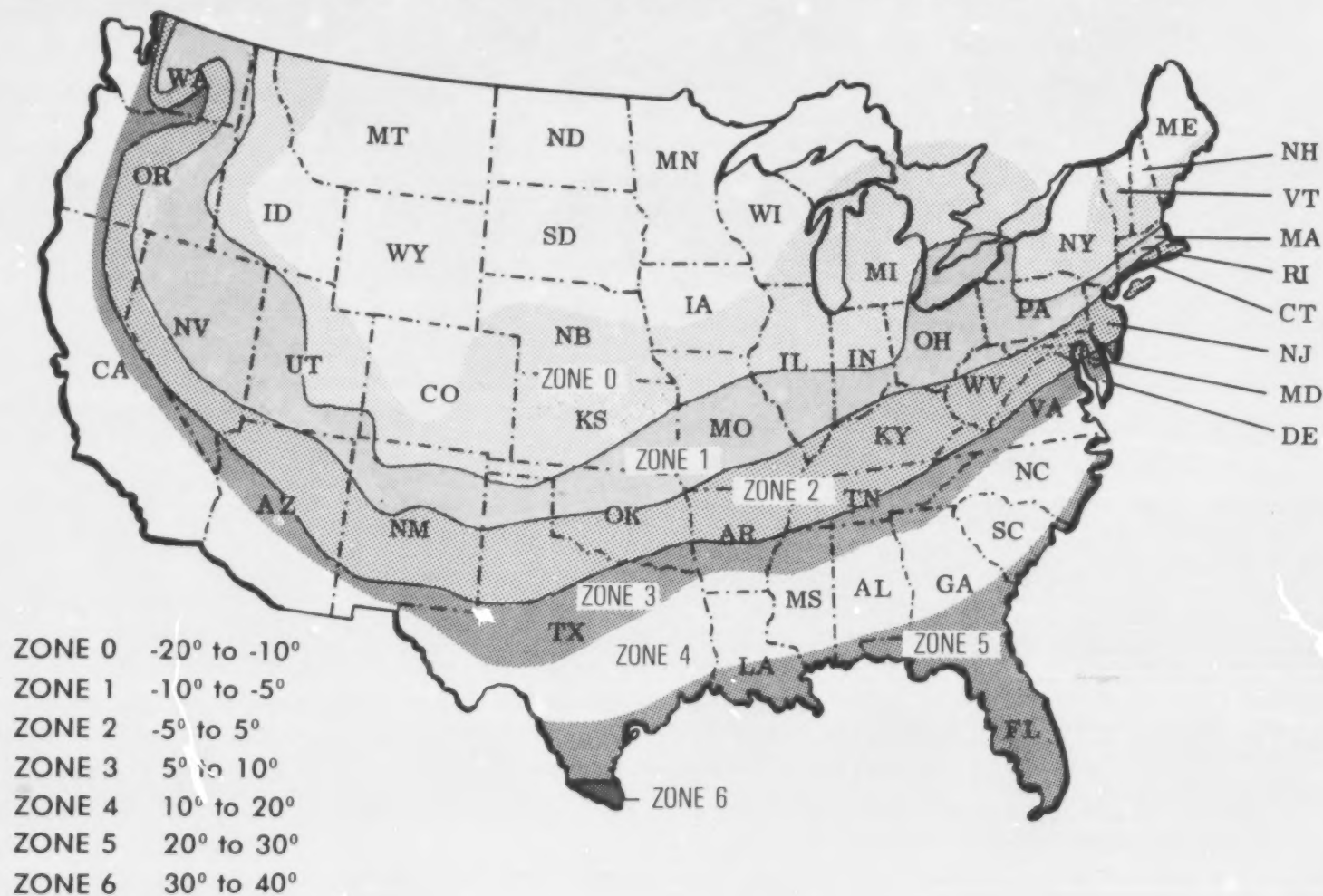


Magnolia



Sweetgum

AVERAGE ANNUAL MINIMUM TEMPERATURES



AGRICULTURAL MECHANICS

Unit A: Farm Electricity

Topic 1: Electrical Safety and Terms

Suggested Procedure and Activities: In addition to the transparencies developed for this lesson, the use of the demonstration boards illustrated in the Texas Education Agency publication, "Wiring and Safety", should be helpful to the teacher in explaining the fundamentals of electricity. Safety in using electricity and the danger of electrical shock should be stressed throughout the lesson.

1. The Meaning of Electricity

For all practical purposes, electricity can be defined as a type of energy that can be converted to light, heat, or power. (Examples - Light bulb, toaster, and motor)

Electricity may also be defined as a movement of electrons which is caused by "electrical pressure" or voltage.

2. Distribution of Electricity to the Farm and Home

Transparency No. 1

The generators at the power plant generate the electricity, developing 13,800 to 22,000 volts.

A step-up substation, through the use of transformers, increases the voltage to 69,000 volts, 132,000 volts, 345,000 volts, and up to 750,000 volts in some cases. This step-up in voltage is necessary for efficient transmission over long distances.

Transformers are used at the step-down substation to reduce the voltage to about 7,200 to 14,000 volts for distribution to rural and city areas.

Transparency No. 2

Transformers at the farm or home reduce the voltage to 120 volts or 240 volts to the meter of the customer.

3. Common Electrical Terms

Transparency No. 3

Electricity

Review the definition as stated earlier. (Energy converted to light, heat, or power.)

Ampere - (Amp.)

A unit of measure of the rate of flow of electricity. (This may be compared with the rate of flow of water in gallons per minute.) It should also be noted that the danger from electrical shock is from amperes flowing through the body.

Volt - (v)

A unit of measure of electrical pressure. Common service voltages are 120 volts or 240 volts. (Voltage may be compared with water pressure in pounds per square inch in a water system.)

Watts - (w)

A measure of electrical power. Electricity is measured in watts and is the work done by volts (pressure) pushing amperes (amps) through a wire. (Watts may be compared to the work done by water in washing a car.)

Kilowatt - (kw)

1000 watts. This unit of measure is used to obtain measurements that are more practical to use in computing electrical energy used. It is obtained by dividing the number of watts by 1,000.

Kilowatthour - (kwh)

Measurement of electricity in terms of power in kilowatts and time in hours. (1,000 watts used one hour.)

Alternating Current - (A.C.)

Current alternates or changes direction several times per second. Voltage can be easily increased or reduced by the use of transformers.

60 cycle

Current alternates or changes direction 120 times per second.

Direct Current - (D.C.)

Current flows in one direction.

Transformer

A device used to increase or reduce voltage.

Single Phase

The most common electric service to farms and homes. Requires one transformer between distribution line and meter.

Three Phase

Electric service that usually requires two or three transformers between distribution line and meter. Not generally available to customers with normal electrical needs. Several large (10 Hp and larger) motors would justify three phase service.

Short Circuit

A direct connection (before current flows through an appliance) between two "hot" wires, between a "hot" and "neutral", or between a "hot" wire and ground.

Voltage Drop

The reduction of voltage between the power supply and the load. Factors affecting voltage drop are size of wire, length of wire, and the number of amperes flowing.

A voltage drop results in loss of heat, loss of light, or loss in power output of a motor. It may endanger a motor if the motor is not properly protected with a time-delay fuse or circuit breaker.

The selection of the proper size wire to provide sufficient voltage to appliances is an important consideration in planning electrical circuit installations. Tables Nos. 2,3,4,5,6,7,8, and 9 in Reference No. 1 may be used by the teacher to demonstrate the selection of wire sizes on the basis of permissible voltage drop.

4. Computing Electrical Power Used By Heating and Lighting Appliances

Transparency No. 3

The basic formula for determining the number of watts used is:

$$\text{Watts} = \text{Volts} \times \text{Amperes}$$

For determining the number of amperes flowing in a circuit:

$$\text{Amperes} = \frac{\text{Watts}}{\text{Volts}}$$

For determining the number of volts:

$$\text{Volts} = \frac{\text{Watts}}{\text{Amperes}}$$

5. Computing Electrical Power Used By Motors

Transparency No. 4

Electric motors are rated or sized in horsepower (Hp). This measurement of mechanical power is equal to 746 watts of electrical power.

Electric motors are not 100% efficient so more than 746 watts are required for a motor to develop one horsepower.

Rules of Thumb for Figuring the Operating Cost of Motors:

1 Hp and larger - Estimate 1000 watts per horsepower

Less than 1 Hp - Estimate 1200 watts per horsepower

6. Cost of Operating Electrical Equipment

Transparency No. 5

Watts x Hours of Operation = Watthours

Kilowatthours (kwh) = $\frac{\text{Watthours}}{1,000}$

Four 200-watt bulbs = $\frac{800 \text{ watts} \times 3 \text{ hours}}{2400 \text{ watthours}}$

$\frac{2400 \text{ watthours}}{1,000} = 2.4 \text{ kwh}$

Electricity @ 6¢ per kwh
 $2.4 \text{ kwh} \times 6¢ = 14.4¢$

Operate a 2 Hp motor (2000 watts) for 2 hours
 $2000 \text{ w} \times 2 \text{ hrs} = 4,000 \text{ watthours}$
 $\frac{4000 \text{ watthours}}{1000} = 4 \text{ kwh} @ 6¢ = 24¢$

Operate a 1/3 Hp motor (400 watts) for 8 hours
 $400 \text{ w} \times 8 \text{ hrs} = 3200 \text{ watthours}$
 $\frac{3200 \text{ watthours}}{1000} = 3.2 \text{ kwh} @ 6¢ = 19.2¢$

7. Parts of an Electrical Circuit

Transparency No. 6

An electrical circuit is a completed path through which electricity flows. Insulated conductors (wires) conduct the electricity.

The "hot" wire from the power source is a current-carrying conductor with electrical pressure (voltage) on it. The "hot" wire, usually black or red, conducts the current to the appliance.

The "neutral" wire conducts the current from the appliance to the source (ground). The "neutral" wire, usually white, has no electrical pressure (voltage) on it.

Most circuits include a switch to open or close the circuit.

Circuits should be protected from too many amperes by a protection device (fuse or circuit breaker).

8. Electrical Circuit Compared To Water System

Transparency No. 7

As indicated earlier, an electrical circuit may be compared to a water system for a clearer understanding of the circuit.

Water Pressure - Electrical Pressure (Volts)
Rate of Flow - Rate of Flow (Amperes)
Work Done - Power (Watts)

If the switches are closed, current will flow through the fuse, hot wire, appliance, and back to source (ground) on the neutral wire.

If the neutral wire is disconnected from the neutral bar in the fuse box and connected to the earth, current will flow. A person standing on the ground may act as a conductor if a hot wire or broken neutral wire is touched, resulting in electrical shock.

9. Differences in 120 Volt and 240 Volt Circuits

Transparency No. 8

The 120 volt circuit has one hot and one neutral wire with the switch and fuse in the hot line. The neutral wire from the appliance is connected to the neutral bar in the fuse box. For safety, the neutral wire should always be solid and not broken or interrupted with a switch or fuse.

The voltage is measured with a voltmeter with one lead on the hot terminal and the other lead on the neutral bar. The number of amperes flowing may be measured with a clamp-on ammeter by encircling the hot or neutral wire with the jaws of the ammeter.

The 240 volt circuit has two hot wires and one safety-ground wire with the switches and fuses in the hot lines. The safety-ground wire, connected to the metal frame of the welder and to the neutral bar, does not carry current unless the welder develops a "short". If a "short" occurs, one of the fuses will "blow" to open the circuit.

The voltage is measured with one lead of the voltmeter on one hot terminal and the other lead of the voltmeter on the other hot terminal. Voltage between either hot terminal and the neutral bar will be one-half of the voltage between the two hot wires. The number of amperes flowing can be measured by clamping a clamp-on ammeter around either hot wire.

10. Safety Grounding Electrical Equipment

Transparency No. 8

The metal frame of an ungrounded electrical tool or appliance may come in contact with a damaged or bare wire inside the frame. The metal case will then be energized or charged with electricity. If the case is touched by a person who is grounded, the current will flow through the person to the ground. The shock could be fatal.

To prevent this possibility of shock, a safety-ground wire, properly installed, will carry the current from the metal case to the ground, causing a direct short which, in turn, will cause the fuse to "blow" or the circuit breaker to open.

The diagram of the 240 volt circuit illustrates the practice of safety grounding. Any electrical appliance may be safety grounded to protect against electrical shock by connecting a ground wire from the metal frame of the appliance to the neutral bar in the panel box. The safety-ground wire may be bare, but if insulated, the insulation of a safety-ground wire is usually green in color.

A current-carrying neutral wire should never be used to connect a safety-ground wire to ground. A safety-ground wire should never be used as a current-carrying neutral wire.

Each outlet circuit should be installed with a safety-ground wire and grounded receptacles should be provided. This will allow any safety-grounded appliance to be plugged into the outlet without an adapter.

When an adapter must be used, the green pigtail wire should be grounded to furnish protection from electrical shock to the operator of the appliance.

Using a test lamp (light bulb in pigtail socket with two leads), show how a circuit is completed between a "hot" wire and a "neutral" wire.

Using the test lamp, demonstrate how to check appliances for "shorts". With appliance plugged into an outlet, touch the appliance frame with one lead of the test lamp while the other lead of the test lamp is grounded to a water or gas line. If test lamp does not burn, turn appliance plug over and check with test lamp again. If light burns, a short exists. (Hot wire is touching the frame of the appliance.) Unplug appliance and explain how to repair.

11. Protecting Electrical Circuits

Each electrical circuit should be protected from an over-load in amperes. Too many amperes flowing through an unprotected circuit will generate heat which may deteriorate or melt the insulation and/or cause a fire.

The number of amperes that any given conductor can carry safely depends upon the kind and size of wire, the type of insulation, and the type of installation.

Allowable current-carrying capacities of various conductors may be found in Table 1 of Reference No. 1.

Types of Circuit Protection

Transparencies Nos. 9,10,11, and 12

a. Common Fuses

- (1) Plug
- (2) Cartridge
- (3) Blade

b. Fusetrons

- (1) Plug
- (2) Cartridge
- (3) Blade

Time Delay
Action

c. Fustats - (Two Parts)

d. Circuit Breakers

Fuses, fusetrons, fustats, or circuit breakers must be of the proper size to protect each individual circuit. (Examples - A No. 14 gauge copper wire should be protected with a 15 ampere protection device. A 20 ampere fuse may be used to protect a No. 12 gauge copper conductor.)

Electric motors cannot be protected by a common fuse. To properly protect motors, the motor circuit must have a time-delay fusetron, fustat, or circuit breaker in the circuit.

The time-delay action allows the higher amperage required for the motor to start to flow for a short time without "blowing" the fuse or opening the circuit breaker. If the high-amperage flow continues after the motor gains its operating speed, the heat will cause the fuse to "blow" or the circuit breaker to open.

This time-delay principle is essential to fuse the circuit closely enough to protect the motor. (The time-delay fuse or circuit breaker should not be more than 25% larger than the amperage rating of the motor. A common fuse of the same size will "blow" each time the motor attempts to start.)

A circuit is not protected when a penny is placed behind a common fuse. Fustats are designed so that a penny cannot be placed behind the fustat. (The opening in the fustat base is too small for the penny) The threads of fustats are designed to prevent over-size fusing.

Excessive ampere flow in a circuit breaker causes the heater strip to heat the bi-metal strip which trips the breaker opening the circuit. The circuit breaker can be reset after it is allowed to cool.

12. No Fault Grounding

Transparency No. 13

Fuses and circuit breakers are safety devices which limit current (amperage) in a circuit.

Their main function is to protect equipment and wiring from overload. Ground fault circuit interrupters (GFI) are designed to protect humans, equipment, and/or electrical systems from injury or damage if electricity flows in an unintended path (a short).

A GFI is a very sensitive device that functions by comparing the current flowing in the "hot" wire with that in the neutral wire. If these two currents are not equal, a fault exists, and current is "leaking" out of the circuit. If the difference in current between the two wires is 5/1000 of an ampere or greater, the GFI will open the circuit, shutting off the power and eliminating any shock hazard.

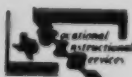
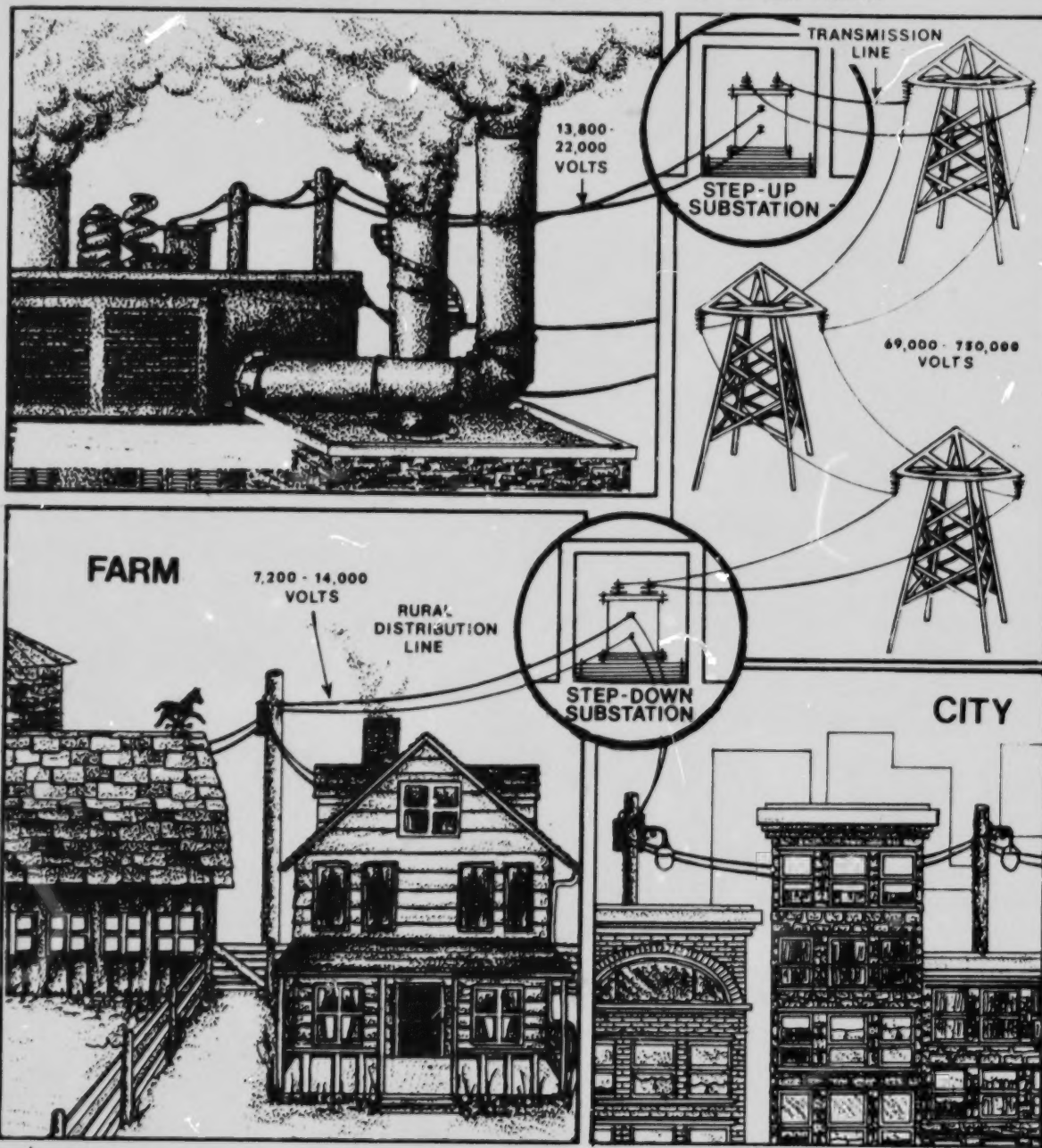
The National Electrical Code requires GFI's for all 120 V, single phase, 15 and 20 amp receptacles installed outdoors, in bathrooms, and in garages for residential buildings. A GFI is required at construction sites and some other applications. After correcting the circuit fault, the GFI may be reset for further use.

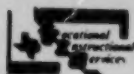
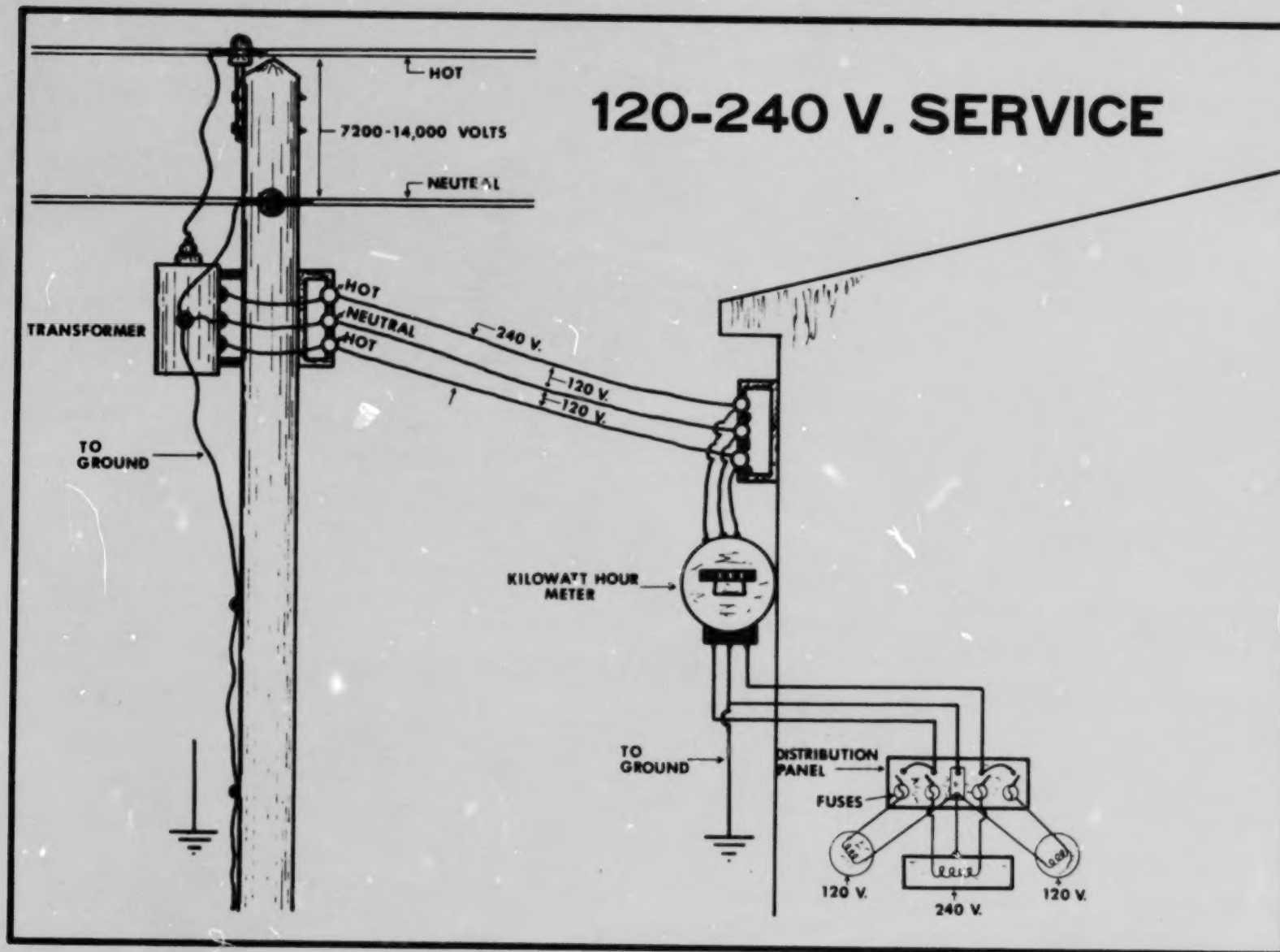
A variety of GFI equipment is made for 120 and 240 volt circuits as indicated in transparency no. 13.

References:

1. Texas Education Agency, "Farm Electrification Lesson Plans - Wiring and Safety", Vocational Instructional Services, Texas A&M University, College Station, Texas.
2. Henderson, G.E., "Electrical Terms - Their Meaning and Use", Vocational Instructional Services, Texas A&M University, College Station, Texas.
3. Hamilton, J.R., Using Electricity On The Farm, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1959.
4. AAVIM, "Electrical Wiring - Residential, Utility Buildings and Service Areas", Vocational Instructional Services, Texas A&M University, College Station, Texas.
5. AAVIM, "Maintaining the Lighting And Wiring System", Vocational Instructional Services, Texas A&M University, College Station, Texas.
6. AAVIM, "Understanding Electricity And Electrical Terms", Vocational Instructional Services, Texas A&M University, College Station, Texas.
7. Food and Energy Council, "Agricultural Wiring Handbook", Vocational Instructional Services, Texas A&M University, College Station, Texas.
8. National Fire Protection Association, "National Electrical Code", Boston, Massachusetts.

HOW ELECTRICITY GETS TO THE FARM





COMMON ELECTRICAL TERMS

electricity - light, heat, power

ampere (amp.) - rate of flow

example: (water - gal./min.)

volt (v) - pressure

example: (lbs./sq. in.)

watts (w) - power

example: (hp)

kilowatts (kw) - 1000 watts

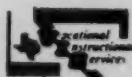
horsepower (hp) - 746 watts = 1 hp

kilowatt-hour (kwh) - 1000 watts used in 1 hour

volts x amps = watts

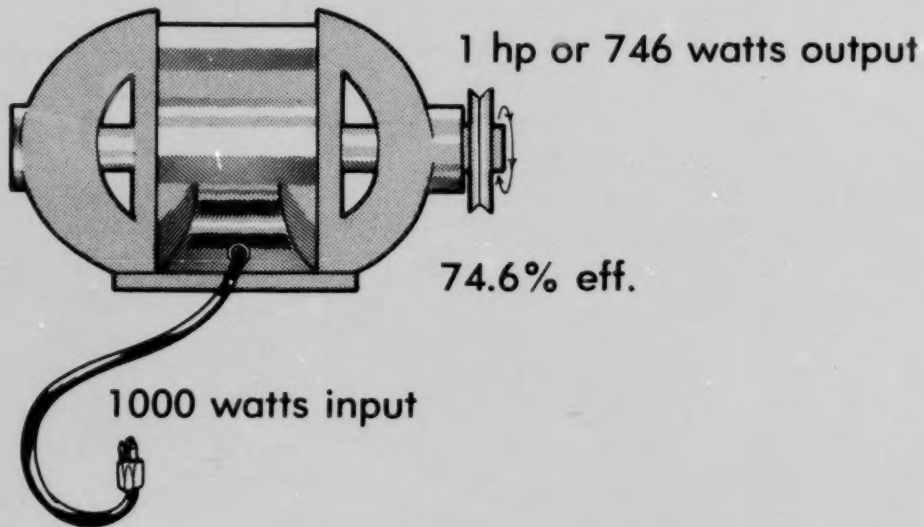
$$\text{amps} = \frac{\text{watts}}{\text{volts}}$$

$$\text{volts} = \frac{\text{watts}}{\text{amps}}$$



EFFICIENCY OF MOTORS

1 HP MOTOR



$$\text{eff.} = \frac{\text{output} \times 100}{\text{input}}$$

$$\text{eff.} = \frac{746 \times 100}{1000} = 74.6\%$$

Rule Of Thumb:

1 HP MOTOR USES 1000 WATTS

COST OF OPERATING ELECTRIC EQUIPMENT

WATTS X HOURS OF OPERATION= WATT HOURS

$$\text{KILOWATT-HOURS (KWH)} = \frac{\text{WATTS} \times \text{HOURS}}{1000}$$

FOUR 200 WATT LAMPS= 800 WATTS
 X 3 HOURS
 2400 WATT HOURS

$$\frac{2400 \text{ WATT HOURS}}{1000} = 2.4 \text{ KWH}$$

ELECTRICITY @ 6¢/KWH

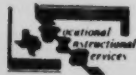
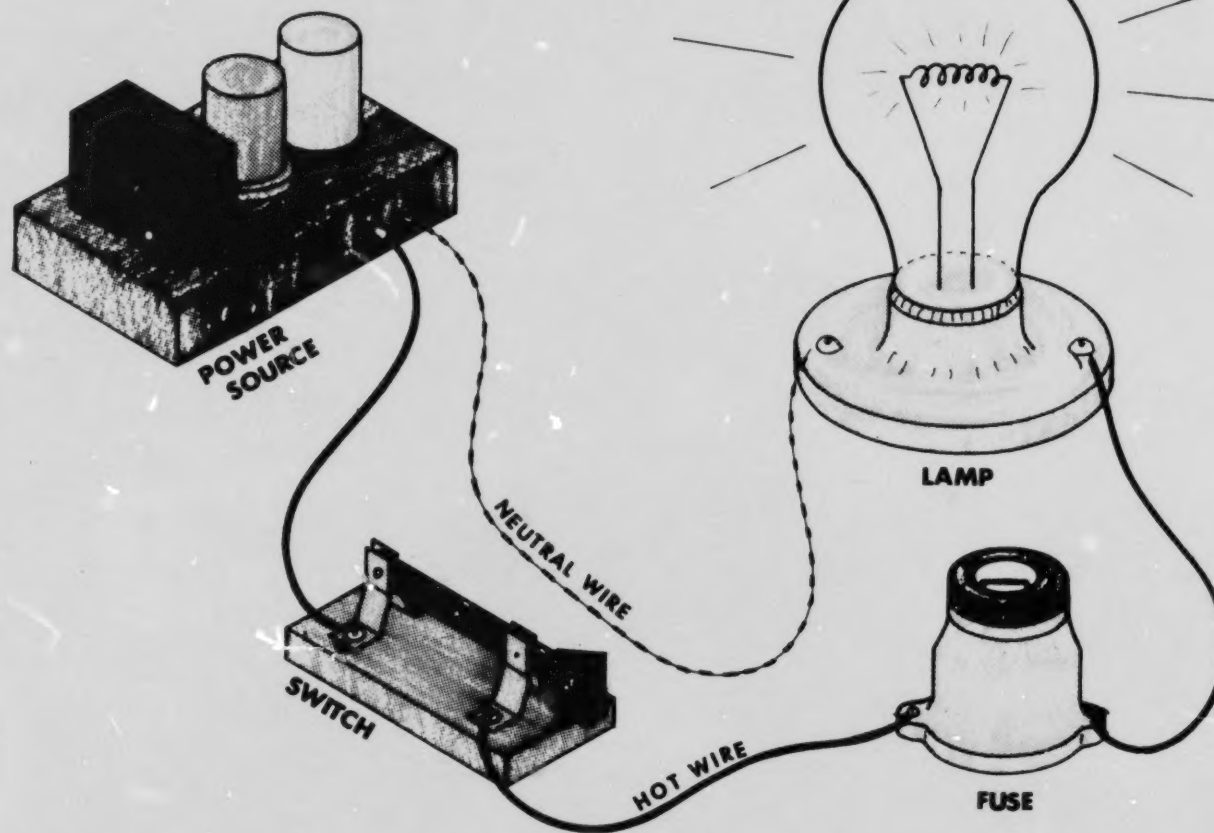
$$2.4 \text{ KWH} \times 6\text{¢/KWH} = 14.4\text{¢}$$

OPERATION OF A 2 HP MOTOR (2000 WATTS)

FOR 2 HOURS= 4000 WATT HOURS=

$$4.0 \text{ KWH} \times 6\text{¢/KWH} = 24\text{¢}$$

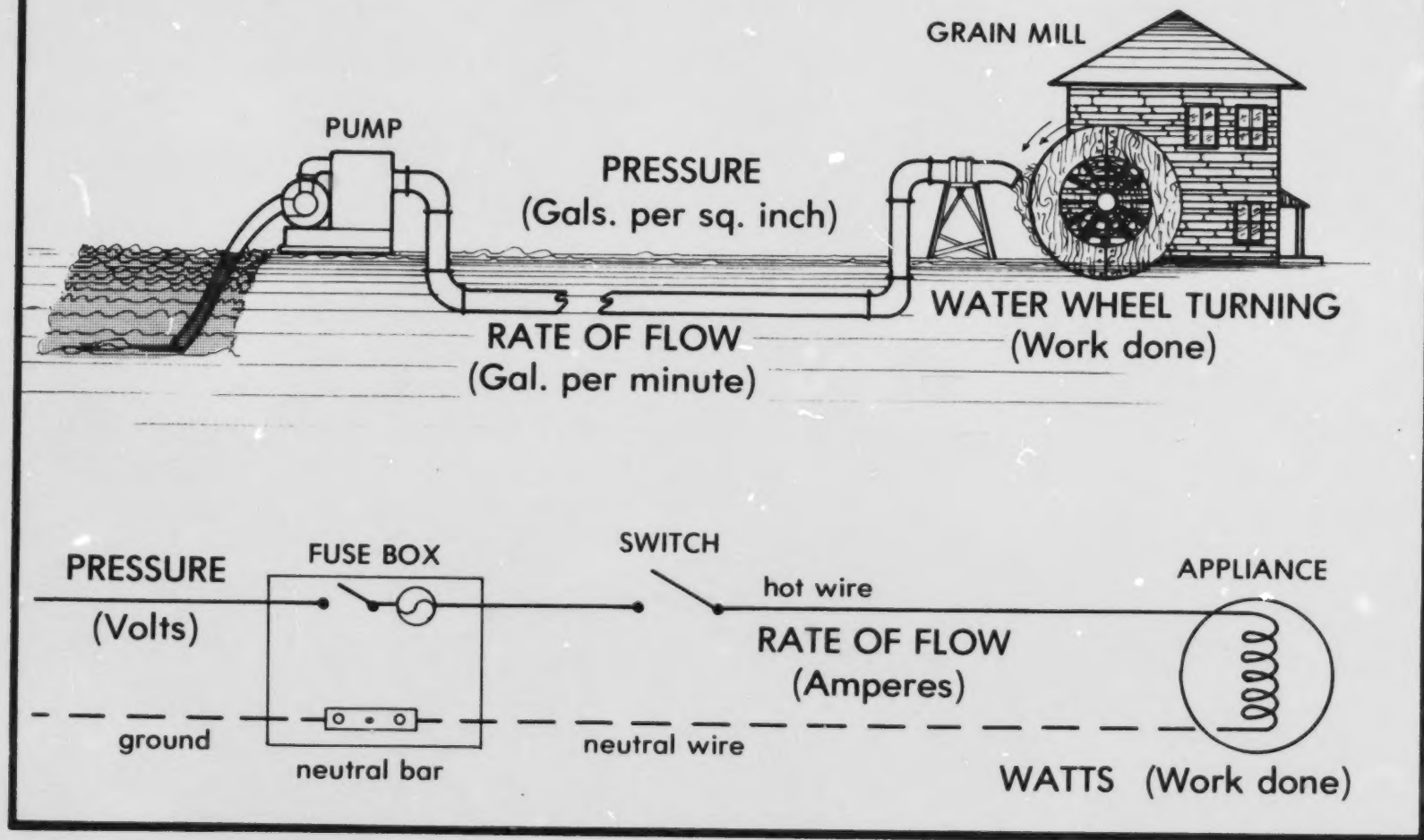
SIMPLE CIRCUIT



V. A. III

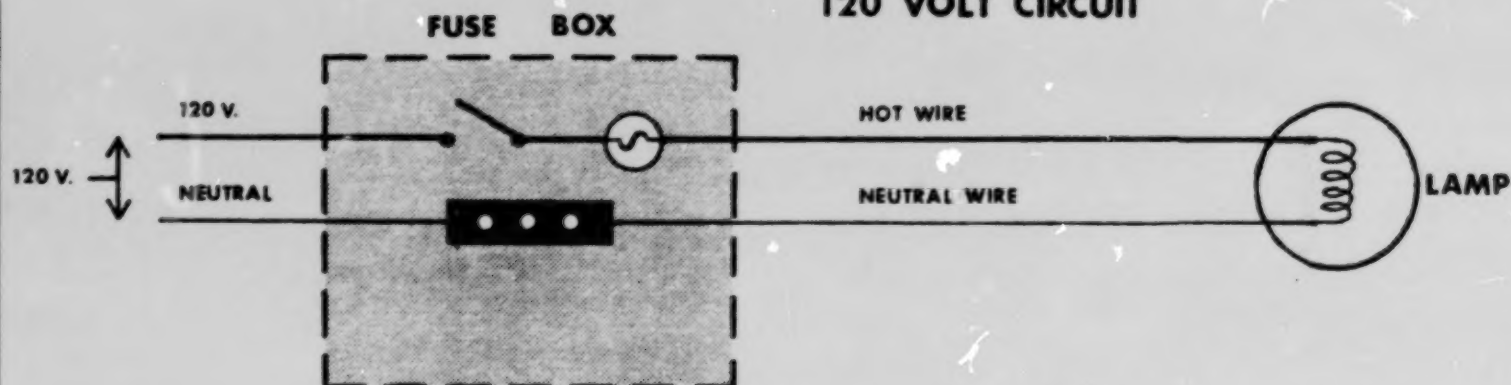
V-A-1
No. 6

WATER SYSTEM — ELECTRIC CIRCUIT

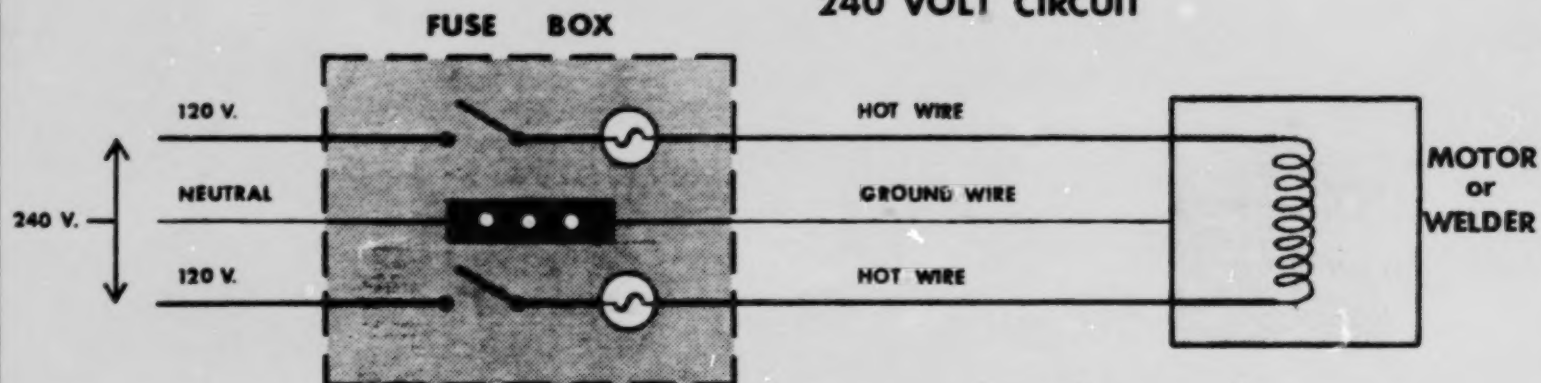


120-240 VOLT CIRCUITS

120 VOLT CIRCUIT



240 VOLT CIRCUIT



CIRCUIT PROTECTION

1. COMMON FUSES

- A. plug
- B. cartridge
- C. blade

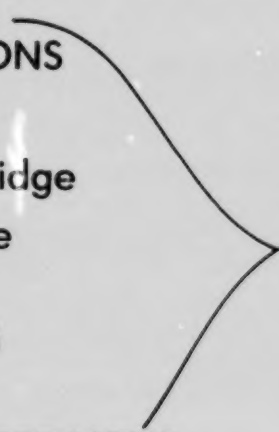
2. FUSETRONS

- A. plug
- B. cartridge
- C. blade

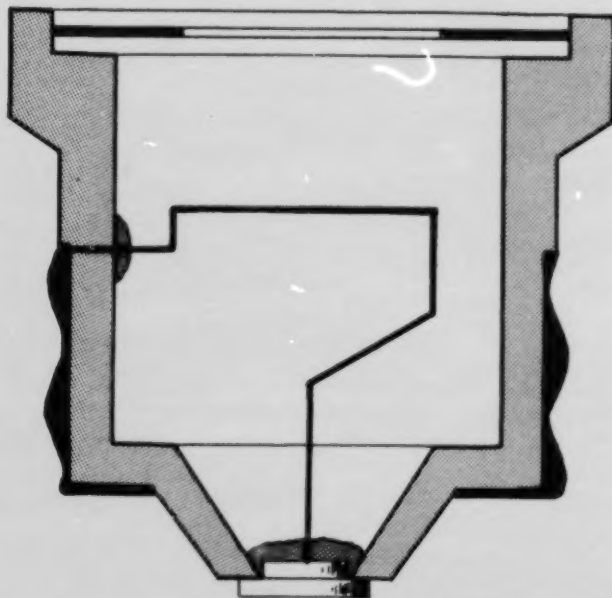
3. FUSTATS

4. CIRCUIT BREAKERS

TIME DELAY
ACTION

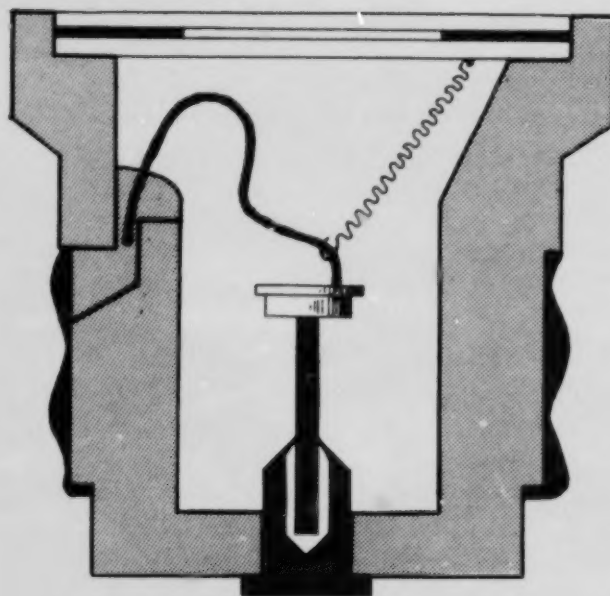


TYPES OF FUSES

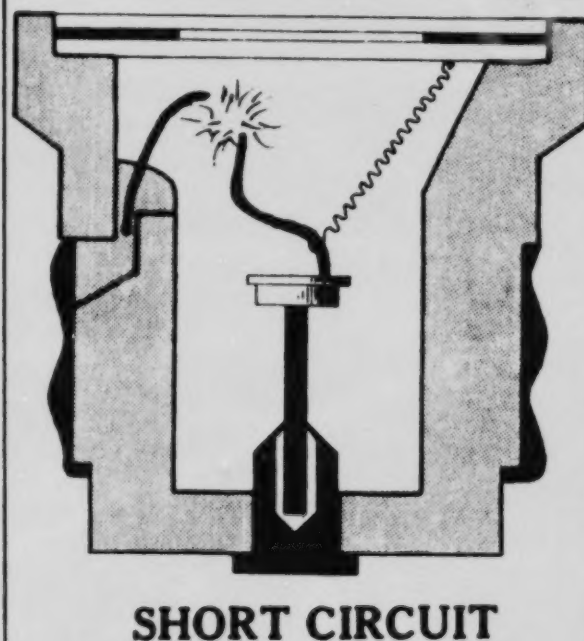
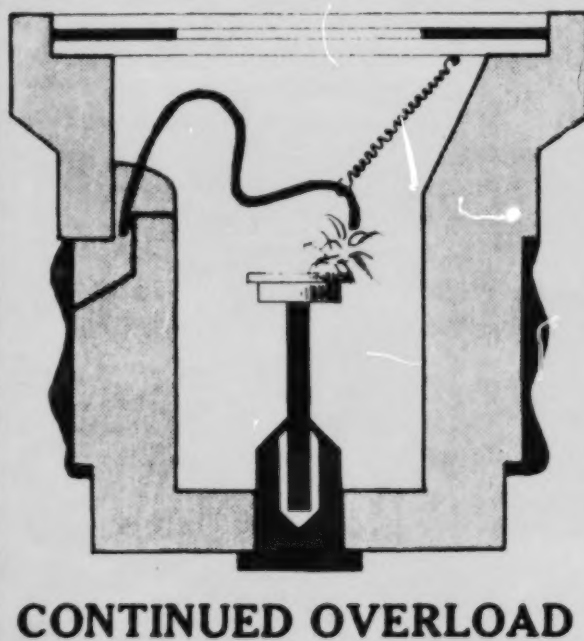
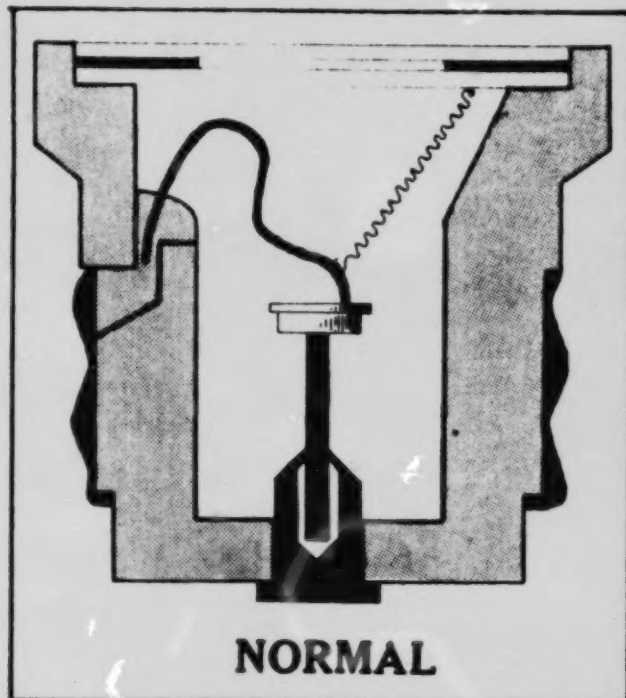


PLUG FUSE

DELAYED ACTION FUSE

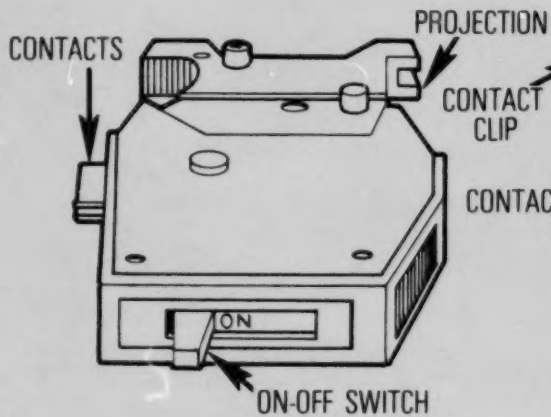


OPERATING PRINCIPLE OF A DELAYED ACTION FUSE

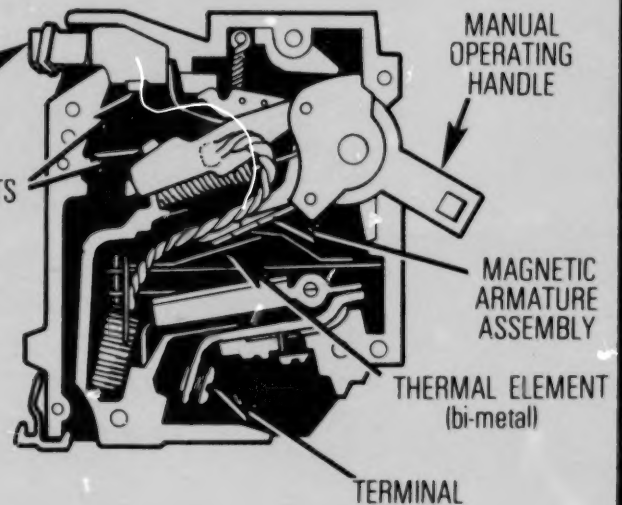


CIRCUIT BREAKER

OUTSIDE

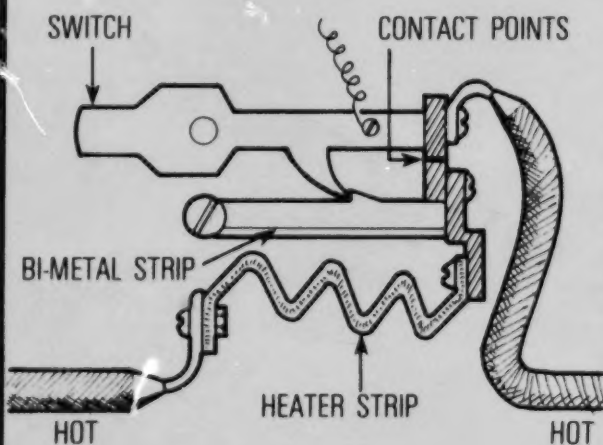


INSIDE

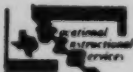
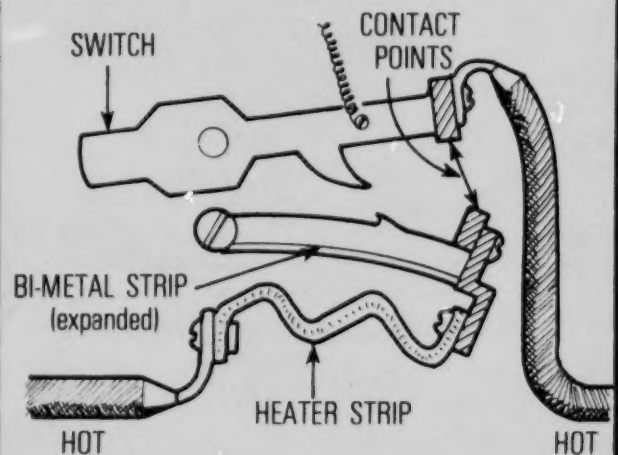


OPERATION

CLOSED

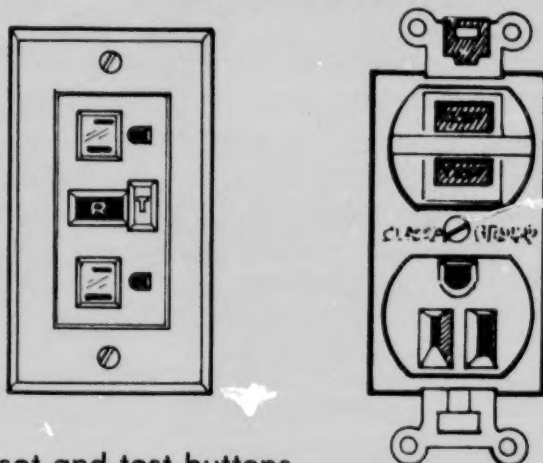


OPEN



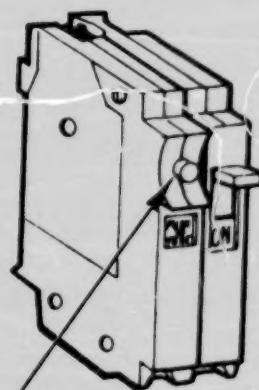
GROUND FAULT CIRCUIT INTERRUPTER EQUIPMENT

GFI RECEPTACLE FOR CONVENTIONAL OUTLET



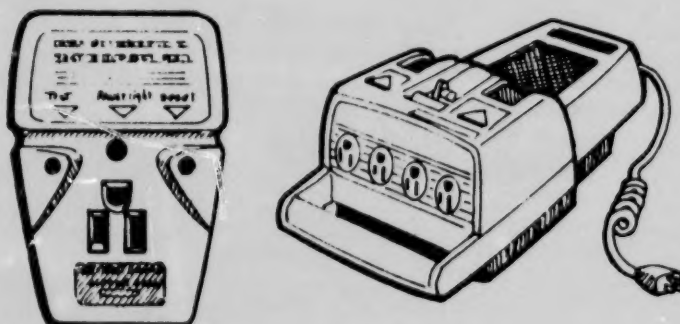
reset and test buttons

GFI TO REPLACE
CIRCUIT BREAKER

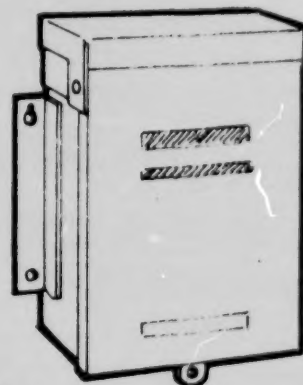


test button

PORTABLE GFI TO PLUG INTO OUTLET



GFI TO INSTALL IN
BRANCH CIRCUIT



AGRICULTURAL MECHANICS

Unit A: Farm Electricity

Topic 2: Wiring Layouts

Suggested Procedure and Activities: In addition to using the transparencies for this lesson, students should be shown the various tools and electrical wiring materials as each is discussed. Following the discussion and demonstration, it is suggested that each student make a test lamp to provide experience in soldering and taping. If available, Demonstration Board No. 3 illustrated in Reference No. 1 may be utilized to point out the various wiring materials.

1. Selecting and Using Common Wiring Materials

An electric circuit requires a conductor that is well insulated to confine the current to the path or circuit desired. The conductor, usually copper or aluminum, may be insulated with rubber, plastic, or other synthetic insulation.

Copper and aluminum are good conductors of electricity. Aluminum wire is lighter in weight and usually less expensive even though it normally requires one size larger than copper wire to carry the same load in amperes.

The use of the wire selection tables in Reference No. 1 will enable the teacher to give students examples of the proper wire selection for various purposes.

Exterior Wiring

Transparency No. 1

Conductors which are used outside must be insulated to stand exposure to the sun and rain. Most exterior conductors are insulated with a material composed of wax and fibers (weatherproof) or a synthetic material (TW).

Porcelain screw-type insulators are commonly used to attach overhead wires to the outside of buildings or poles.

Service entrance cable (SE) is used to carry the current into a building. The wires in the service entrance cable are attached to the exterior wires with split-bolt connectors (service connectors). The service entrance cable is placed through a service entrance head (weatherhead) to prevent rain from entering the cable.

Interior Wiring

Transparency No. 1

The service entrance cable is placed through the outer wall and is connected to the terminals of the service entrance panel (load center, breaker box or fuse box). The load center panel may contain one or more positions for branch circuits in the building.

Transparencies Nos. 1 and 2

The wiring in the building may be concealed or exposed. The most common type of wire for branch circuits in a building is non-metallic sheathed cable (Romex). This cable has two or more insulated conductors, may be obtained with a safety ground wire, and is covered with a fabric or synthetic sheath.

Three principal types of outlets in wiring circuits are lighting outlets, appliance or convenience outlets, and special purpose outlets. The lighting outlets may be porcelain light receptacles or elaborate fixtures. Appliance or convenience outlets are used for small appliances and the special purpose outlets are provided for each major appliance. The National Electric Code requires that outlets be of the grounded type.

The most common type of switch is the single-pole toggle switch. It will control one or more lights or appliances from one location. To control a circuit from two locations, two three-way switches are used. To control a circuit from three or more locations, four-way switches are placed between the two three-way switches. The installation and wiring of switches will be discussed in the next lesson.

Every outlet and splice should be housed in a metal or synthetic outlet box. Depending on their purpose, boxes are referred to as switch boxes, outlet boxes, or junction boxes. Each outlet box should have a cover in place.

2. Planning The Wiring Layout

Transparency No. 3

Requirements of A Good Wiring System

Safe

Circuits must have wire sizes that satisfy safe ampere capacity. They must be fused properly and installed according to the National Electric Code.

Adequate

The system should provide convenience in the number and location of outlets and switches. Sufficient voltage should be provided to all appliances with no more than 2% voltage drop for lighting and heating appliances and with no more than 3% voltage drop for motors. An adequate number of circuits should be provided to supply present and anticipated needs.

Economical

Should be safe and adequate at a minimum cost.

Planning the Wiring System

After determining the number of circuits needed, a diagram of all circuits should be prepared.

For general purpose circuits, a convenience outlet should be provided for every twelve feet of wall space. Each circuit should have no more than eight convenience or light outlets.

Because of high wattage appliances used in the kitchen, at least two general purpose circuits should be installed.

Special purpose circuits should be provided for major appliances such as range, water heater, clothes dryer, and air conditioner. Special circuits should also be provided for the food freezer and water system.

At least 20 to 24 branch circuits are recommended for an average home.

The common graphical electric symbols shown on Transparency No. 4 should be used in making a wiring diagram.

Transparency No. 4

3. Making Common Splices and Connections

Improper splices and connections may cause poor electrical service and can be a very serious fire hazard or life safety factor. Any splice or connection should be made so that it will be as solid as the conductors that are joined.

Three Basic "Home-made" Splices

Transparencies Nos. 5 and 6

Western Union

This is used when strength is required. Remove enough insulation to allow 5 or 6 turns. Wrap one wire around the other, keeping loops close and tight. Solder and tape.

Center Tap

Use this to branch off in another direction. Wire should be anchored to an insulator because this splice does not have strength. Remove insulation at an angle. Solder and tape.

Rat Tail

Use this in junction boxes where the cable is clamped in a box and strength is not needed. Remove insulation at an angle. Solder and tape.

Soldering Splices

Transparency No. 7

After determining that wires are clean, heat the wire until it melts the rosin core solder and the solder flows into all of the spaces.

Taping Splices

Transparency No. 7

Using plastic tape, lap halfway over each turn, keeping the tape tight as each wrap is made. Extend the tape over the original insulation at each end. Two complete wrappings over the splice result in four thicknesses of tape which are usually sufficient for proper insulation.

Solderless Connectors

Transparency No. 8

Solderless connectors may be used instead of soldering. The proper solderless connector should be selected for each specific purpose.

4. Making A Test Lamp

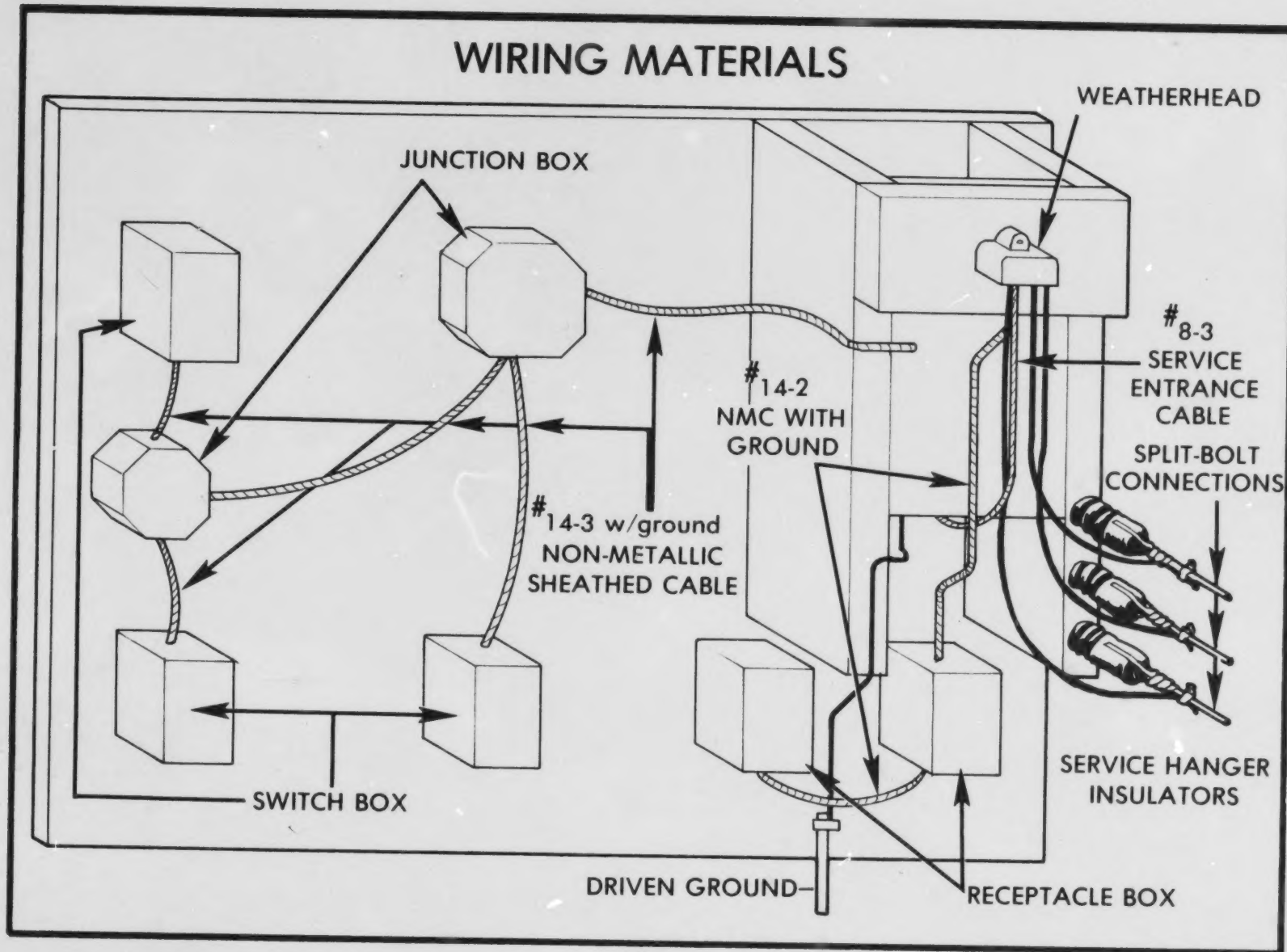
It is suggested that a test lamp be made by each student after the teacher has demonstrated how to solder and tape a western union splice. The skills of splicing, soldering, and taping should be performed by each student while making the test lamp.

References:

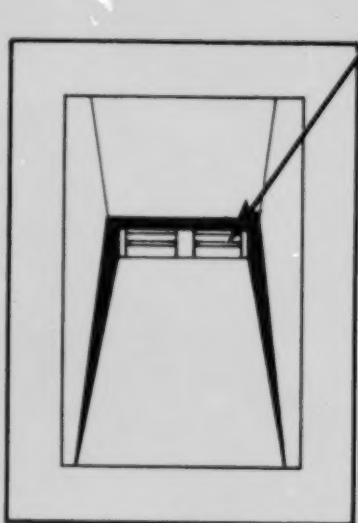
1. Texas Education Agency, "Farm Electrification Lesson Plans - Wiring and Safety", Vocational Instructional Services, Texas A&M University, College Station, Texas.
2. Hamilton, J.R., Using Electricity On The Farm, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1959.
3. Sears Roebuck and Co., "Simplified Electric Wiring Handbook", Vocational Instructional Services, Texas A&M University, College Station, Texas.
4. AAVIM, "Maintaining The Lighting And Wiring System", Vocational Instructional Services, Texas A&M University, College Station, Texas.

5. National Fire Protection Association, "National Electrical Code",
Boston, Massachusetts.

WIRING MATERIALS



INTERIOR WIRING MATERIALS



FUSELESS LOAD CENTER
(flush mounted)

TWO BREAKERS
(15 amp)



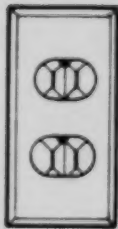
4" PORCELAIN
LAMP RECEPTACLE



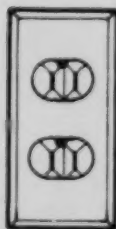
3-WAY SWITCH



4" PORCELAIN
LAMP RECEPTACLE



DUPLEX OUTLETS (grounded)



TOGGLE SWITCH



3-WAY SWITCH

REQUIREMENTS OF A WIRING SYSTEM

- 1. THE SYSTEM MUST BE SAFE**
- 2. THE SYSTEM MUST BE
ADEQUATE**
 - a. CONVENIENCE**
 - b. GOOD VOLTAGE**
 - c. ENOUGH CIRCUITS**
- 3. THE SYSTEM MUST BE
ECONOMICAL**

ELECTRICAL SYMBOLS

GENERAL OUTLETS



LIGHTING OUTLET



CEILING LIGHTING OUTLET FOR RECESSED FIXTURE (OUTLINE SHOWS SHAPE OF FIXTURE.)



LIGHTING OUTLET WITH LAMP HOLDER



LIGHTING OUTLET WITH LAMP HOLDER AND PULL SWITCH



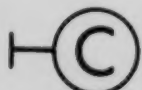
FAN OUTLET



JUNCTION BOX



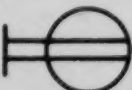
DROP-CORD EQUIPPED OUTLET



CLOCK OUTLET

TO INDICATE WALL INSTALLATION OF ABOVE OUTLETS, PLACE CIRCLE NEAR WALL AND CONNECT WITH LINE AS SHOWN FOR CLOCK OUTLET.

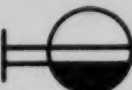
CONVENIENCE OUTLETS



DUPLEX CONVENIENCE OUTLET (GROUNDING TYPE OUTLET REQUIRED)



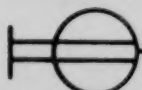
TRIPLEX CONVENIENCE OUTLET (SUBSTITUTE OTHER NUMBERS FOR OTHER VARIATIONS IN NUMBER OF PLUG POSITIONS, SUCH AS 1 FOR SINGLE CONVENIENCE OUTLET)



DUPLEX CONVENIENCE OUTLET - SPLIT WIRED



WEATHERPROOF CONVENIENCE OUTLET



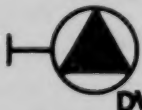
COMBINATION SWITCH AND CONVENIENCE OUTLET



FLOOR OUTLET



RANGE OUTLET



SPECIAL-PURPOSE OUTLET. USE SUBSCRIPT LETTERS TO INDICATE FUNCTION. DW-DISHWASHER, CD-CLOTHES DRYER, ETC.

SWITCH OUTLETS



SINGLE-POLE SWITCH



DOUBLE-POLE SWITCH



THREE-WAY SWITCH



FOUR-WAY SWITCH



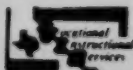
WEATHERPROOF SWITCH



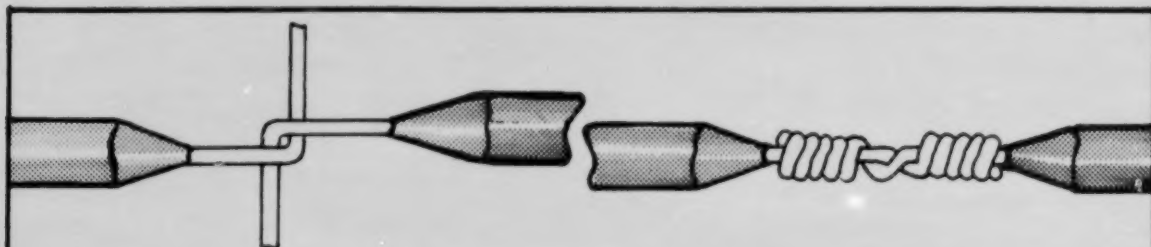
AUTOMATIC DOOR SWITCH



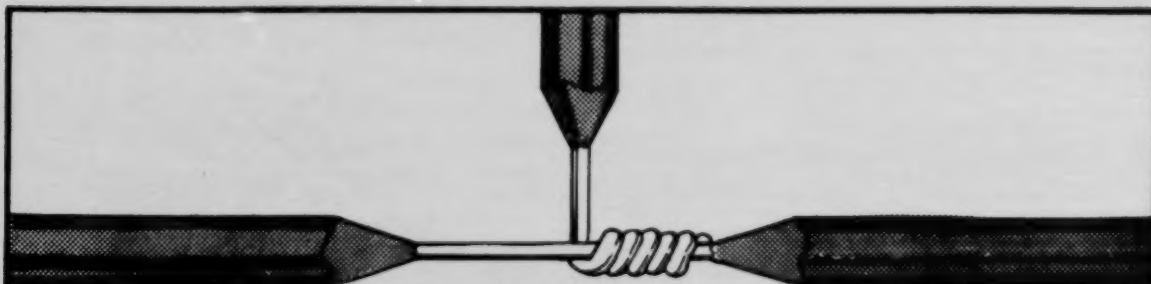
SWITCH AND PILOT LIGHT



SPLICING



WESTERN UNION SPLICE



CENTER TAP SPLICE



**RAT TAIL
SPLICE**

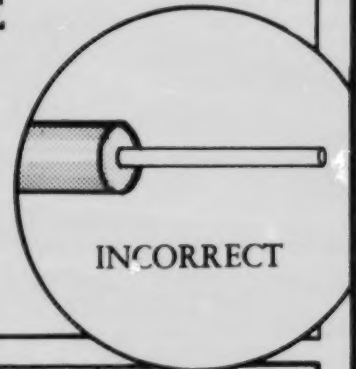
CONNECTING WIRES

CUTTING WIRE WITH A KNIFE

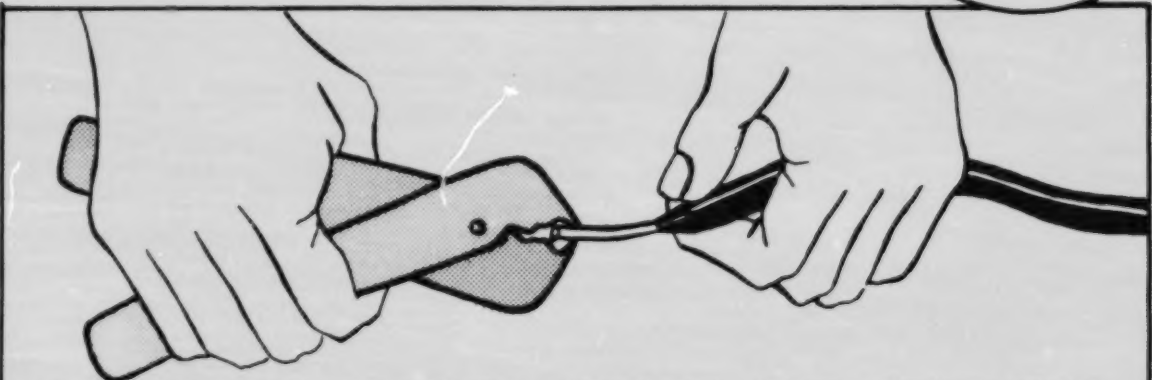


CORRECT

REMOVE INSULATION BY CUTTING AT A SLANT....AS IN SHARPENING A PENCIL EXPOSE 1/2 INCH OF COPPER CONDUCTOR, REMOVE ALL PARTS OF INSULATION, BUT NOT TIN COATING WHICH HELPS SOLDERING.



INCORRECT



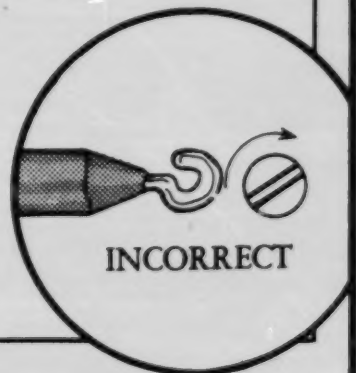
COMBINATION WIRE CUTTER AND STRIPPER

MAKES A HANDY TOOL THAT CUTS AND STRIPS CLEAN ALL SIZES OF SOLID OR STRANDED COPPER WIRE. USE ALSO FOR LOOPING WIRES UNDER SCREWS.



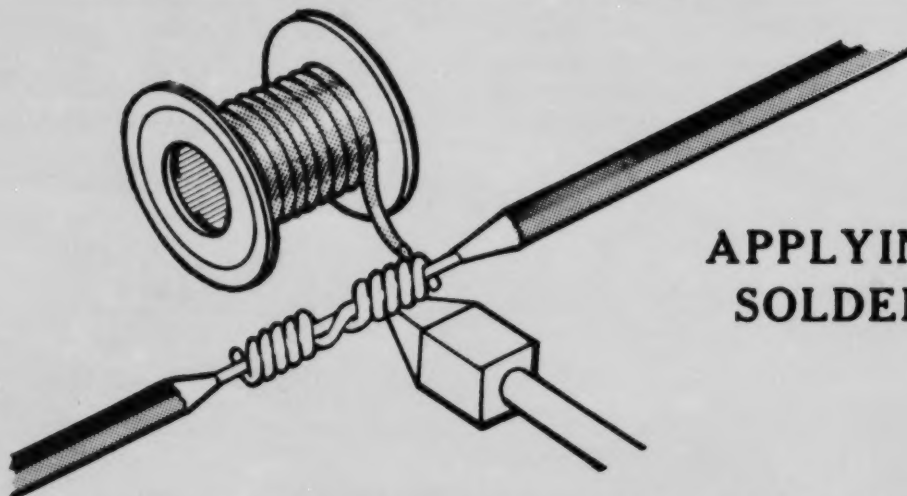
CONNECTIONS AT SCREW TERMINALS

BEND END OF METAL WIRE INTO A LOOP TO FIT AROUND SCREW. BE SURE TO ATTACH LOOP IN DIRECTION IN WHICH SCREW TURNS WHEN TIGHTENING AS ILLUSTRATED ABOVE.



INCORRECT

SOLDERING & TAPING



APPLYING SOLDER

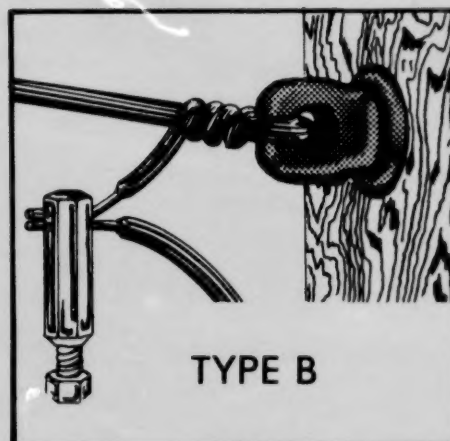
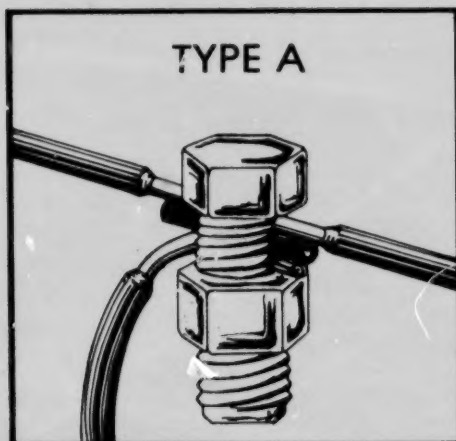
SO SOLDER WILL FLOW EASIER, FIRST COAT WIRES WITH ELECTRIC SOLDERING PASTE. WITH SOLDERING IRON, HEAT WIRES UNTIL SOLDER MELTS AND FLOWS INTO EVERY CREVICE.

APPLYING PLASTIC TAPE

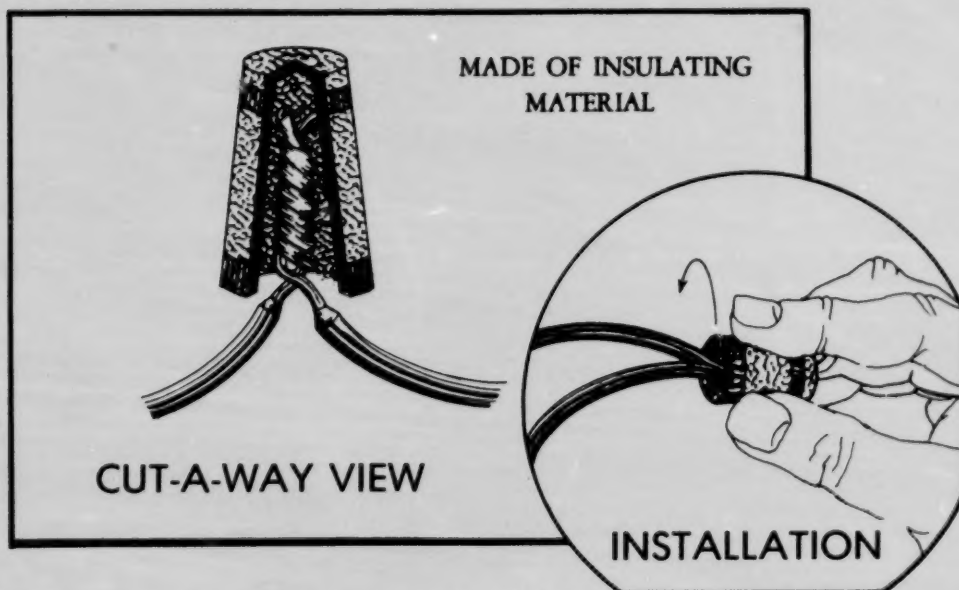


PLASTIC TAPE DOES A FASTER, NEATER, CLEANER JOB THAN RUBBER AND FRICTION TAPE. EASIER TO HANDLE, TAKES LESS SPACE IN BOXES. DOES THE WORK OF BOTH RUBBER AND FRICTION TAPE. WATER-PROOF ACID-PROOF.

SOLDERLESS CONNECTORS



On runs to buildings and to power feed lines use solderless connectors. Type A taps an existing line with strain on wires. Use Type B for electric service connections. Insulate with plastic tape.



Solderless connectors eliminate the need for soldering joints. Some are made of insulating material so wires need not be taped. . . short circuits cannot occur. Just screw connector over wires as shown.

AGRICULTURAL MECHANICS

Unit A: Farm Electricity

Topic 3: Electrical Wiring

Suggested Procedure and Activities: In addition to using the transparencies, it will be most helpful for the teacher to use Demonstration Boards Nos. 3, 4, and 5 illustrated in Reference No. 1 in the explanation and demonstration of the following information and skills to be performed.

1. Types of Switches Used In Electrical Wiring

Transparency No. 1

Simple Switches

Simple switches (single pole-single throw) control a circuit from one location. They may be obtained with toggle, mercury, silent, rocker button, or push button operation.

A thermostat or humidistat is a type of single pole switch.

Single pole switches have two screws (terminals) and two positions - open or closed.

Switches are never installed in a neutral line.

Transparency No. 2

This wiring diagram illustrates how a single pole-single throw switch is connected in a circuit to control a light.

With the switch in the fuse box in the closed position, the current flow can be traced to the switch, through the switch when closed, through the light, and back to the source on the neutral wire.

Transparency No. 3

Three-way Switches

Three-way switches are referred to as single pole-double throw switches.

Three-way switches have three screws (terminals). One screw is the common or pivot terminal. The other two screws are called traveler terminals.

Three-way switches are used to control a circuit from two locations.

The wiring diagram at the bottom of Transparency No. 3 illustrates the principle of operation of three-way switches and how they are connected.

The hot wire from the power source is connected to the pivot terminal (usually the single terminal at one end of the switch) of one of the switches. Each of the traveler terminals of one switch is connected to a traveler terminal of the other switch. The pivot terminal of the remaining switch is connected to the hot lead of the light. The neutral lead of the light is connected to the neutral wire.

The current flow can be traced from the hot source wire and through the circuit to show that either switch will turn the light on or off.

Transparency No. 4

Four-way Switches

Four-way switches have four screws or terminals. They are used between two three-way switches to control a circuit from additional locations.

Four-way switches are installed in the two traveler wires of the three-way switches.

This wiring diagram illustrates the operating principle of a four-way switch and the connections that are made. The traveler wires between the two three-way switches are cut and attached to the terminals of the four-way switch as shown. (Each traveler wire is connected to feed straight through the four-way switch).

The current flow can be traced from the hot source wire and through the circuit to show that either switch will turn the light on or off. (The two positions of the four-way switch feed straight through or feed diagonally).

2. Installation of Lighting And Outlet Circuits

The wiring diagrams that have been used to illustrate the various connections have not shown the wiring, boxes, outlets, and controls as they must be actually installed. It is important that each student properly install all of these as they should be done in actual practice.

The Wiring Demonstration Board No. 3 in Reference No. 1 or similar practical installations may be used for student practice. All connections and splices should be made in boxes. The wire used and all installations made should be the same as would be used and made in a building.

No. 14 romex with ground wire should be used for the outlet circuit. No. 14 three-wire romex should be used between the three-way switches. White insulated wires used for hot wires should be marked in each box with black plastic tape. Solderless connectors should be used to make the splices. Demonstrate stripping romex and removing the insulation from wires prior to installation.

Transparencies Nos. 5 and 6

The wiring diagram should be drawn and explained by the teacher, using Transparency No. 5. Each student should draw the wiring diagram as it is drawn by the teacher prior to the actual performance of the skills.

The following procedure will make use of an electrical demonstration board found in most vocational agriculture shops. No. 14 wire should be used on the demonstration board for ease in making connections. In actual wiring procedures No. 12 wire is required by the National Electrical Code. No. 14-2 romex with ground should be used for both the outlet and lighting circuit. No. 14 three-wire romex with ground should be used between the three-way switches. Use black plastic tape to mark white wires when used as hot wires. Solderless connectors should be used to make splices. Romex clamps are used to secure cables to boxes.

Outlet Circuit - Strip the romex and remove the insulation from the black and white wires, place the romex into the breaker box, and connect the black wire to the breaker terminal. Connect the white and bare wires to the neutral bar. Place the other end of the romex through the first outlet box, strip and remove the proper amount of insulation. Connect the black wire to the brass screw (small slot side of outlet), the white wire to the silver screw (large slot side of outlet), and the bare wire to the safety-ground (green) screw. Use the same color code and connect the first outlet to the second outlet with another length of romex. Install outlets and place covers on the outlet boxes.

Lighting Circuit - Place No. 14-2 romex with ground into the breaker box. Strip the romex and remove the proper amount of insulation. Connect the black wire to the breaker terminal and the white and bare ground wires to the neutral bar. Push the other end of the romex into the first junction box then strip and remove the insulation. Using another length of No. 14-2 romex with ground, place one end into the junction box and the other end into the first switch box. Strip and remove the proper amount of insulation.

Install another No. 14-2 romex with ground from the first junction box to the second junction box for the light to be controlled by 3-way switches. Strip and remove the proper amount of insulation.

Using No. 14-3 romex with ground, run a length from the second junction box to each of the 3-way switch boxes. Strip and remove the proper amount of insulation.

All wire has now been run and connections can be made at this point. In the first junction box, the following splices should be made: (1) Black wire from breaker box to white wire (marked with black tape) from the first switch box and to the black wire going to the second junction box, (2) Black wire from switch box and black lead of the light, (3) White wire from breaker box to white lead of the light and to white wire going to the second junction box, (4) Bare safety ground from the breaker box, switch box, and second junction box should be attached to a grounding clip. Place the porcelain light fixture on the junction box and install the light fixture.

In the first switch box, connect the black wire to one switch terminal and the white wire (marked with black tape) to the other terminal. Attach the bare safety ground to the switch box using a grounding clip. Using grounding clips, attach the bare ground wire to each switch box.

In the three-way switch boxes, connect the black wire to the common terminal and the red and white wires to the traveler terminals of the three-way switches. The white wires should be marked with black tape. Using grounding clips, attach the bare ground wire to each switch box.

In the second junction box, make the following splices: (1) Black wire from the first junction box and black wire from one three-way switch, (2) Black lead of light and black wire from the second three-way switch, (3) Red traveler wires, (4) White traveler wires (marked with black tape), (5) White wire from the first junction box and white lead of the light, (6) Bare ground wire from the first junction box and from each three-way switch should be attached to a ground clip.

Mount the porcelain light fixture on the junction box and install three-way switches and cover plates.

Energize the fuse box and check the circuits and switches to determine if they function properly. Note: Since the safety-ground wire is used, it is most important that the circuit be polarized when energized. (Polarizing the circuit means that the neutral wire is connected to the neutral wire of the circuit board).

References:

1. Texas Education Agency, "Farm Electrification Lesson Plans-Wiring and Safety", Vocational Instructional Services, Texas A&M University, College Station, Texas.
2. AAVIM, "Maintaining The Lighting and Wiring System", Vocational Instructional Services, Texas A&M University, College Station, Texas.
3. AAVIM, "Electrical Wiring, Utility Buildings and Service Areas," Vocational Instructional Services, Texas A&M University, College Station, Texas.
4. Sears Roebuck & Co., "Simplified Wiring Handbook", Vocational Instructional Services, Texas A&M University, College Station, Texas.

SIMPLE SWITCHES

(CONTROL THE CIRCUIT FROM ONE LOCATION)

SINGLE POLE - SINGLE THROW

TOGGLE

MERCURY

SILENT

ROCKER BUTTON

PUSH BUTTON

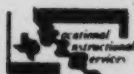
THERMOSTAT

HUMIDISTAT

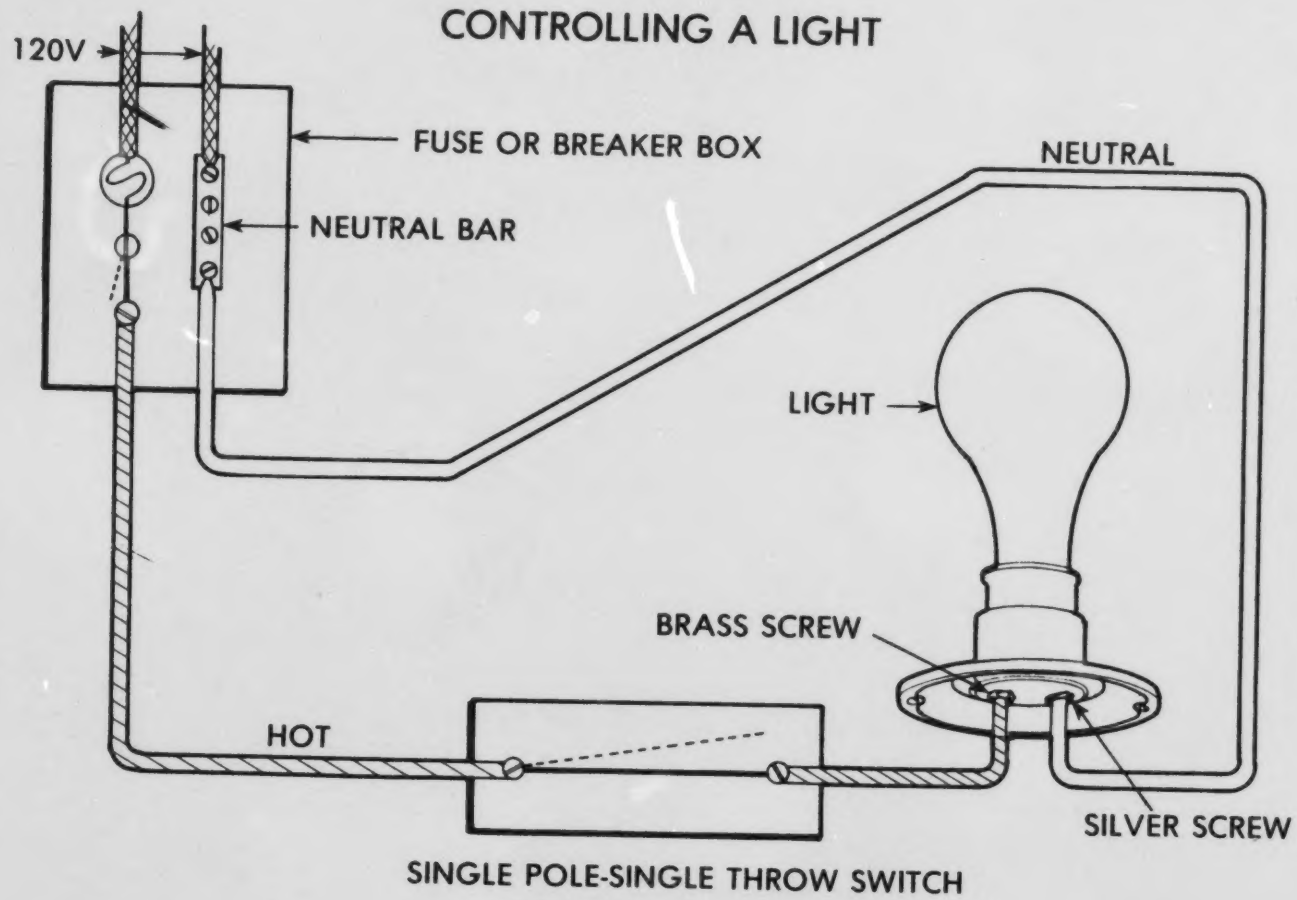
SIMPLE SWITCHES—

HAVE TWO SCREWS

**HAVE TWO POSITIONS-OPEN OR CLOSED
ARE NEVER INSTALLED IN A NEUTRAL LINE**



SIMPLE SWITCH CONTROLLING A LIGHT



THREE-WAY SWITCH

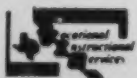
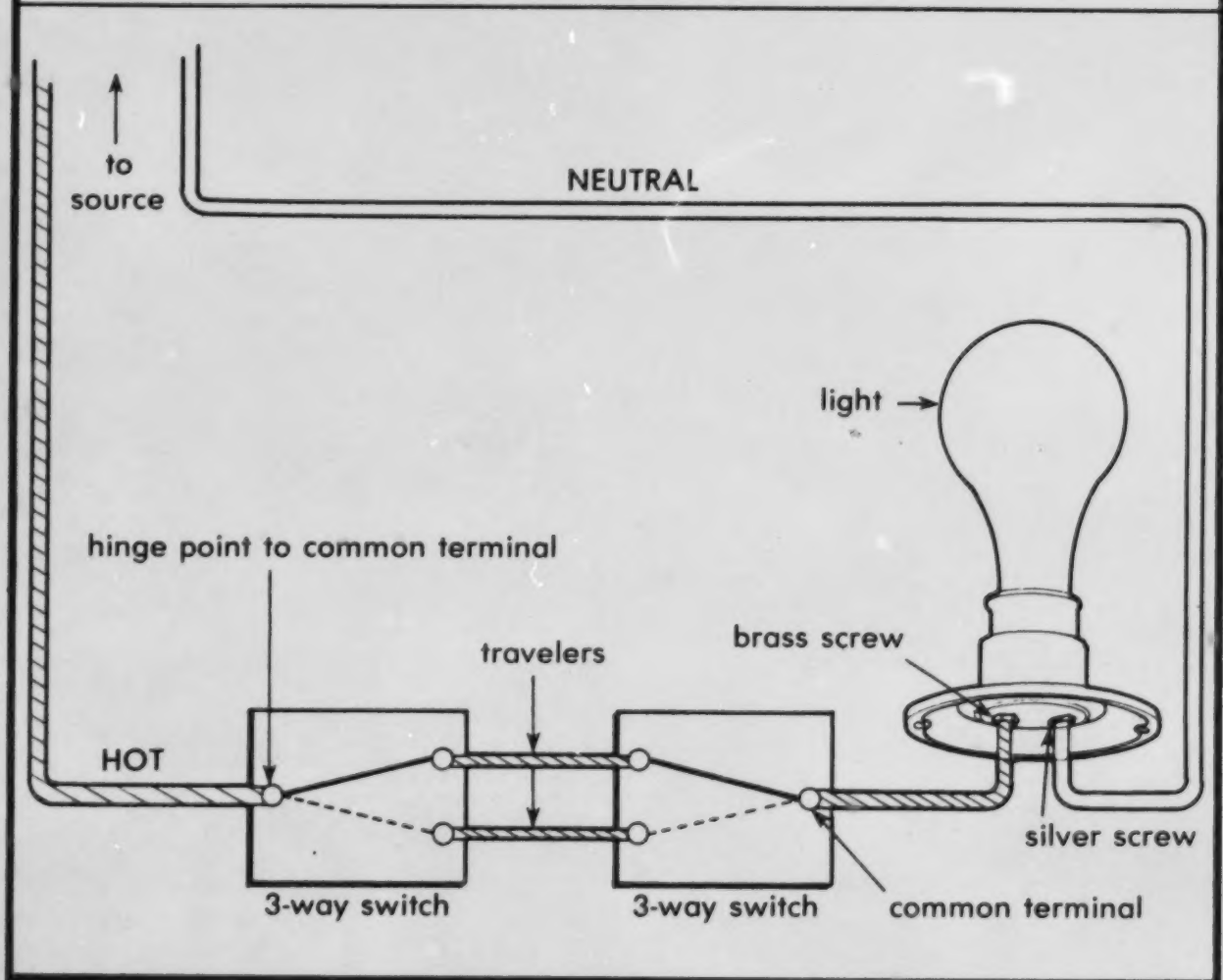
SINGLE POLE - DOUBLE THROW

THREE SCREWS ON SWITCH

ONE SCREW - COMMON OR
PIVOT TERMINAL

TWO SCREWS - TRAVELER TERMINALS

USED TO CONTROL CIRCUIT FROM TWO LOCATIONS

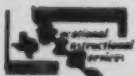
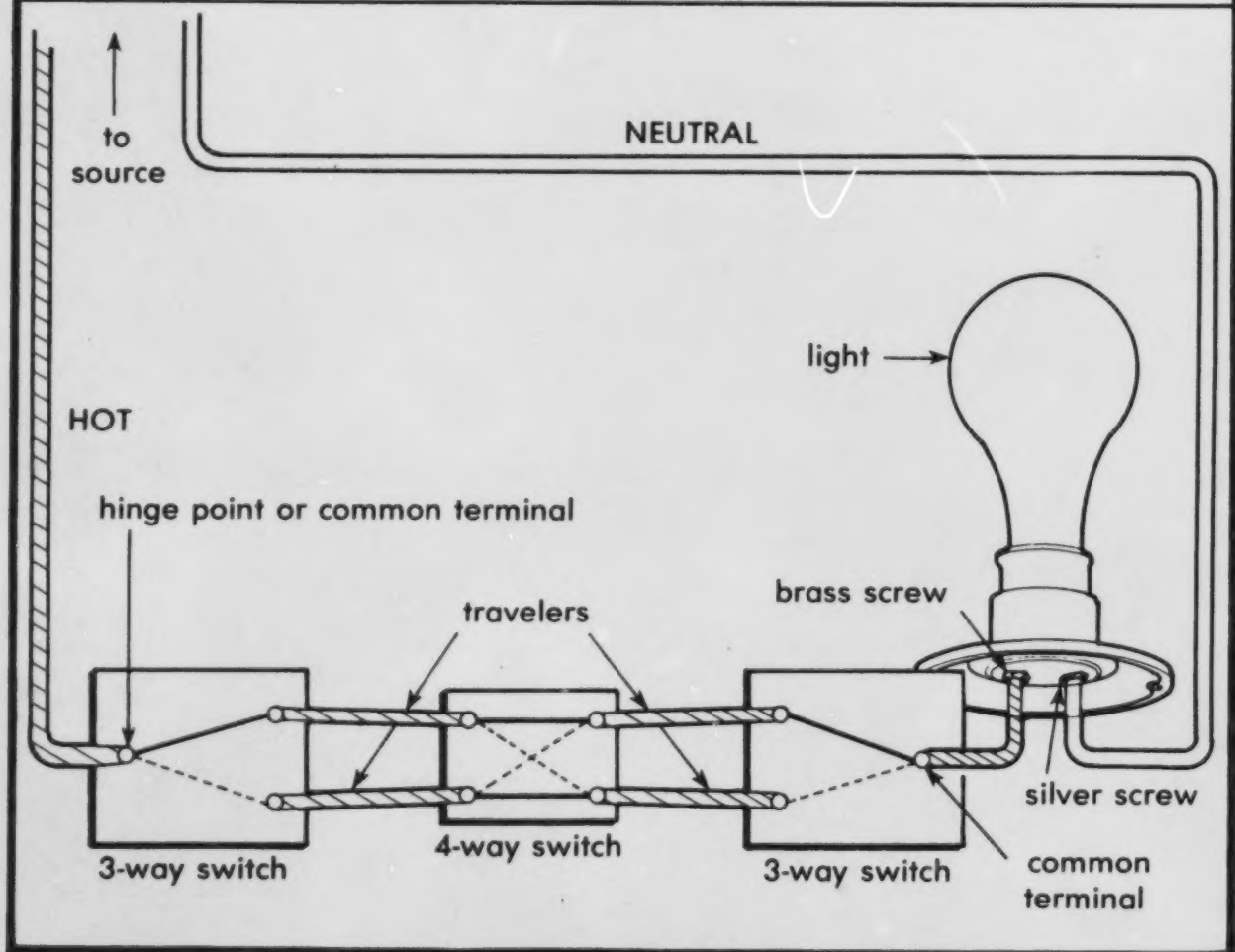


FOUR-WAY SWITCH

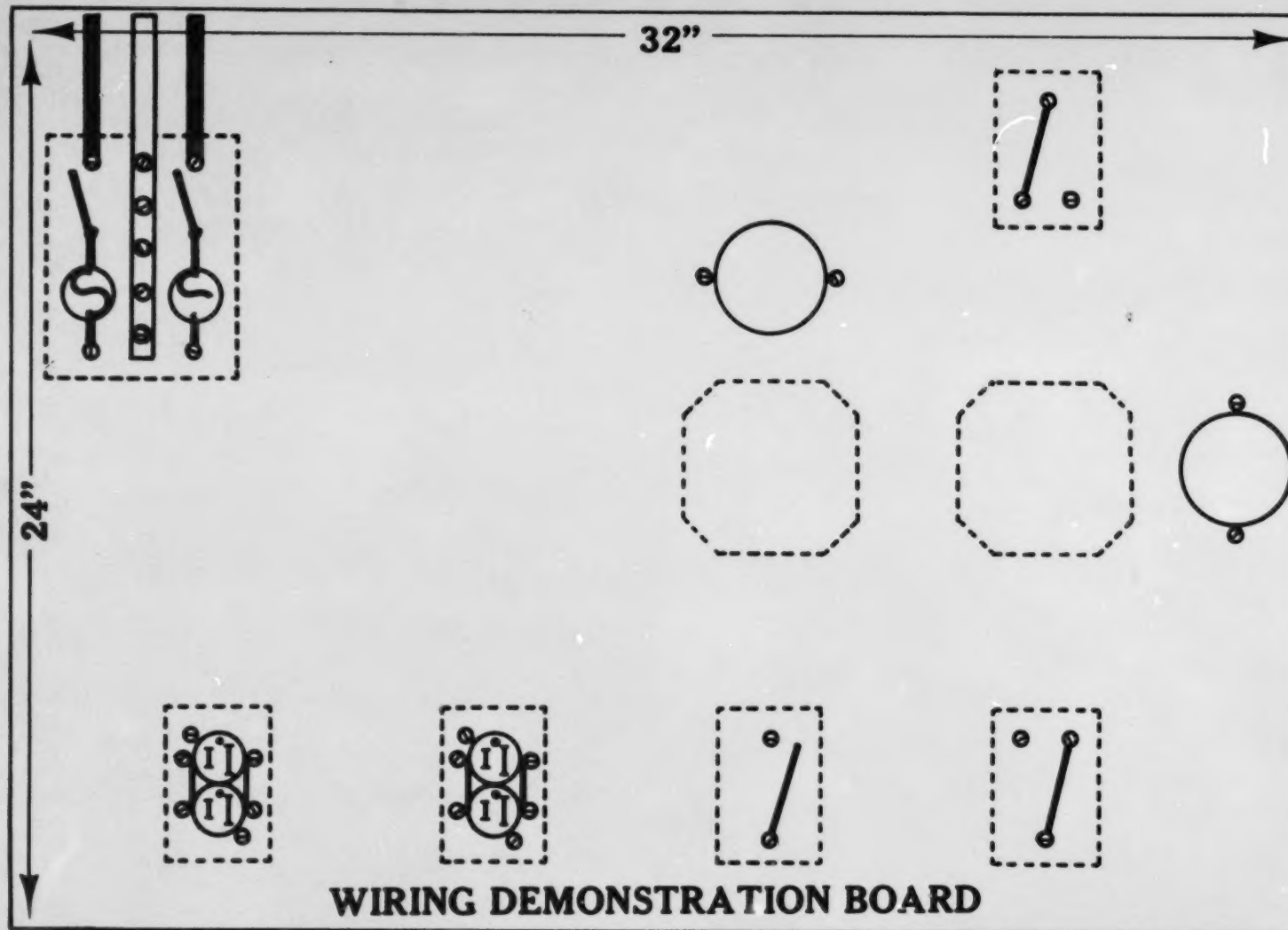
FOUR SCREWS OR TERMINALS

USED BETWEEN TWO THREE-WAY SWITCHES
TO CONTROL CIRCUIT FROM LOCATION

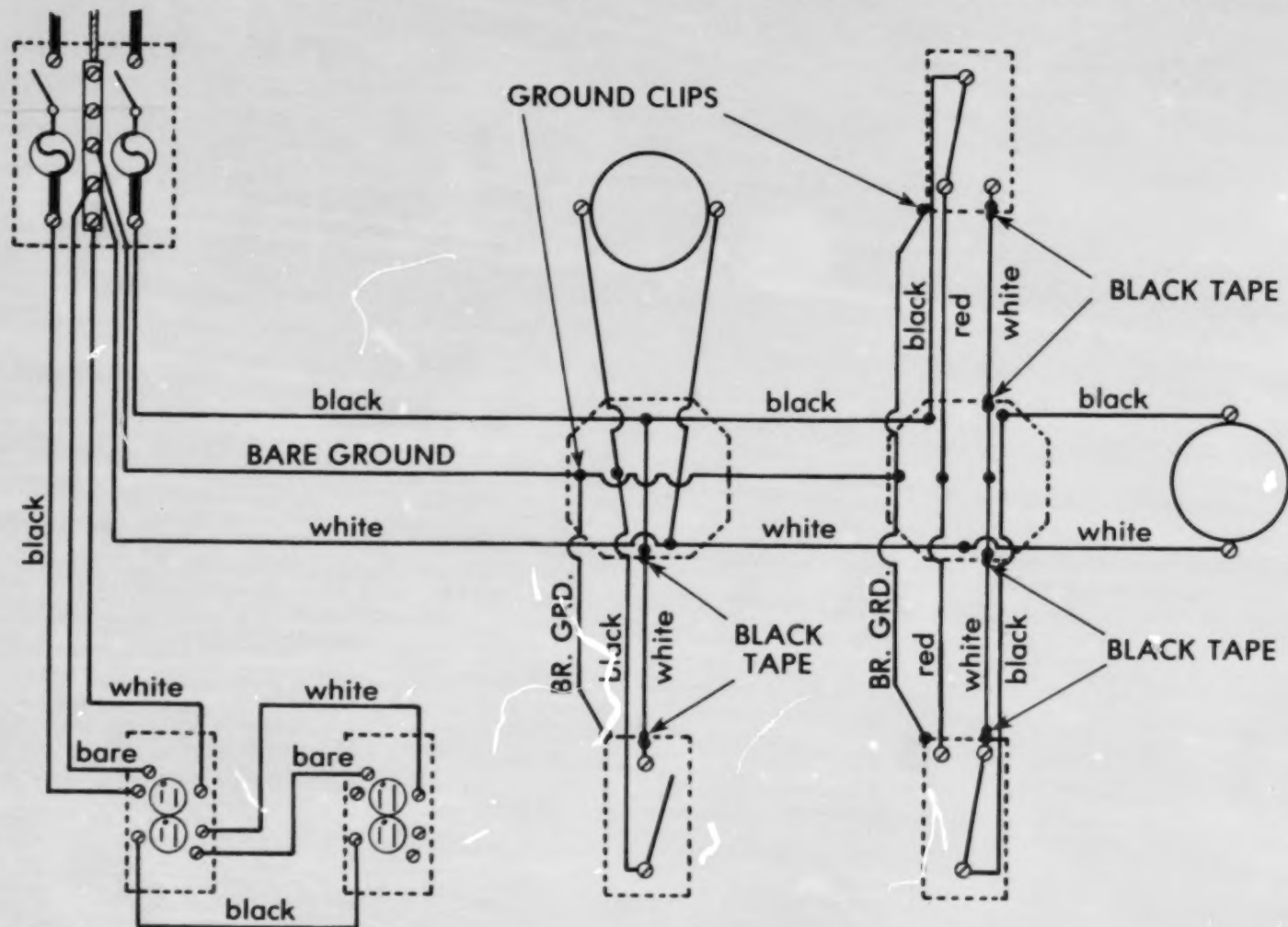
INSTALLED IN TWO TRAVELER WIRES
OF THE THREE-WAY SWITCHES



WIRING LAYOUT



WIRING DIAGRAM FOR OUTLET AND LIGHTING CIRCUITS



AGRICULTURAL MECHANICS

Unit A: Farm Electricity

Topic 4: Types and Uses of Electric Motors

Suggested Procedure and Activities: During the discussion and explanation of the information in this lesson, the transparencies may be utilized along with a display of the different types of motors that are available to the teacher. A demonstration of the use of the continuity test lamp in checking motor windings should assist students in understanding the operating principles and the installation procedures as they are discussed.

1. Advantages of Electric Motors

Transparency No. 1

Inexpensive to Operate

An electric motor can work continuously. A 1/4 Hp motor can do the physical work that two men can accomplish. (The cost of operating electric motors may be reviewed).

Always Ready to Work

Temperature extremes and changes have little effect on motor starting or operation.

Efficient

Compared to other power sources, the electric motor is one of the most efficient. The efficiency of electric motors will vary from 65 to 90 percent.

Long Life

Having few moving parts with little to wear out enables a motor to last many years with proper care.

Simple to Operate

No special skills or experience are required to operate electric motors. They can be started and stopped by a simple switch.

Safe

Electric motors are safe if properly installed. They require no inflammable fuel and produce no dangerous flames or fumes. They have no open gears and require no physical labor to be started.

Minimum Servicing

Electric motors require a minimum of attention - no fuel to carry, no oil to change, or battery to change.

Quiet Operation

Operate quietly and smoothly with very little vibration.

Compact and Easily Automated

Require little space and can be automatically and remotely controlled.

Adaptable

Electric motors are light and can be easily moved. They are adaptable to different operating positions and conditions.

2. Factors To Consider In Selecting Electric Motors

Transparency No. 2

Type of Power Available

The type of electric service available is important because a 230 volt motor should not be selected if only 115 volt circuits are available. Also, a three-phase motor cannot be operated on an electrical system that has only single-phase service. Most of the common motors discussed here will be single-phase, single voltage (115 volt) or dual voltage (115 or 230 volt) motors.

Size of Motor

The size of electric motors is rated in horsepower. The rating given to a motor refers to the power that it will develop when the motor is turning at full speed.

Two "rules of thumb" for estimating the size of motor needed are:

- (a) If the equipment can be operated by hand, a 1/4 Hp motor will usually be adequate.
- (b) If a gasoline engine is to be replaced by an electric motor, an electric motor approximately 2/3 the Hp rating of the engine will usually be adequate.

Starting Load

The motor selected must have the starting torque or turning force to start the load. Various motors have different methods of starting. Based upon the method of starting, there are seven types of motors. These are:

- (a) Split-Phase
- (b) Capacitor-Start

- (c) Split-Capacitor Start
- (d) Repulsion Start
- (e) Series or Universal
- (f) Shaded Pole
- (g) Three-Phase

The characteristics and common uses of these motors will be discussed later in this lesson.

Speed Requirement

Electric motors are rated at the speed the shaft will turn in revolutions per minute (r.p.m.) when the motor is operating at full speed. The r.p.m. of the motor should be the speed needed to operate the equipment at the proper speed.

Type of Bearings

Electric motors may have sleeve bearings or ball bearings. Motors with ball bearings will normally require less maintenance and can be mounted in any position.

Type of Base

The motor may need a rigid base, a sliding base that is adjustable, or a cushion mount to reduce vibration and wear.

Environment

The type of motor enclosure (frame) should be selected to provide proper protection to the motor from its surroundings - primarily protection from dust, dirt, and water.

The four common types of enclosures available are: (1) Open-Dripproof (2) Splashproof (3) Totally Enclosed-Fan Cooled and (4) Explosion Proof

3. Nameplate Information On An Electric Motor

The nameplate on an electric motor provides important and helpful information to assist a person in selecting the proper motor for the job, in making the installation, and in energizing the motor with the proper voltage.

Transparency No. 3

A.C. - 1 PH

This indicates the motor will operate on alternating current and single phase power.

Motor Type

This refers to the model or motor type as designated by the manufacturer.

Thermoguard Type

The motor has a built-in protection device that protects the motor from too many amperes. The thermal relay will open the circuit if the ampere flow becomes high enough to endanger the motor windings. The thermal relay may close automatically after it cools or it may be the manual-reset type that requires an operator to push the reset button each time the thermal relay opens.

HP-1/2

The motor is rated at 1/2 horsepower.

R.P.M. - 1725

The shaft of the motor will turn at 1725 r.p.m. when pulling its rated load.

Cycle - 60 (Hertz)

The motor is to be used on 60 cycle current.

°C - 40

This indicates the temperature rise in the windings that will occur when the motor is operated at rated load and voltage under normal conditions.

Hours - Cont.

This motor is designed to operate continuously, while some are designed to operate intermittently.

Volts - Amps

The voltage on which the motor will operate is designated. If it is a single-voltage motor, only one voltage rating will be designated. A dual-voltage motor will have both voltages shown. The number of amperes are shown under each voltage and are to be considered the ampere ratings of the motor at its rated load. (Note that the ampere rating at 240 volts is exactly one-half the ampere rating when wired with 120 volts).

The proper wiring diagram of the terminal block should be followed for the voltage to be used.

This motor can be reversed (rotate shaft in opposite direction) by interchanging the red and yellow leads on the terminal block. Other motors may be reversed by other methods which will be discussed later. Some motors may not be reversed.

Open

This indicates the conditions under which the motor can be operated.

The "open" frame designation means that the motor should not be used in a wet or dusty environment.

Some of the nameplate information is not discussed here because it is for the manufacturer's use or it will be discussed later in this lesson.

4. Characteristics And Uses of Common Electric Motors

Transparency No. 4

Split-Phase Motor

- (a) This is used for loads that are easy to start.
- (b) This type has a high starting current requirement and will draw 6 to 8 times its normal running current when starting.
- (c) The sizes normally available are from 1/20 Hp to 3/4 Hp.
- (d) It is considered a constant speed motor and is a single voltage motor except in the 1/2 Hp and 3/4 Hp sizes.
- (e) This is one of the least expensive motors and is of simple construction.
- (f) It has a starting winding, starting switch, and a running winding.
- (g) This type has many applications for easy starting loads. Examples listed are emery wheel, bench saw, washing machine, and seed cleaner.

Transparency No. 5

- (h) The wiring diagram for a single voltage, split-phase motor is illustrated here. Note the starting switch is in the starting winding. The starting switch is closed when the motor is at rest. As the motor reaches about 80% of its running speed, the starting switch opens which stops the flow of current through the starting winding.

One end of the starting and running windings are placed together for one lead and the other ends of both windings are placed together for the other lead.

To reverse the rotation of the shaft, the ends of the starting windings are changed with respect to the running winding leads.

Transparency No. 6

- (i) Each of the windings in a motor may be identified by the use of the continuity test lamp illustrated in this transparency.

If the leads of the continuity test lamp are connected to the ends of different windings, the light will not burn when plugged into an outlet. The winding being tested must complete the circuit in order for the light to burn.

When power leads are connected to the ends of the running winding, the motor will hum. The shaft can be turned either direction by hand and the motor will run.

When power leads are connected to the ends of the starting winding, the motor will start and stop as the centrifugal mechanism closes and opens the starting switch.

Transparency No. 7

Capacitor-Start Motor

- (a) As the name indicates, this motor has a capacitor in the starting winding to give the motor more starting force. It is used for loads that are fairly difficult to start.
- (b) It has medium starting current requirement and will draw 3 to 6 times its normal running current when starting.
- (c) It is considered a constant speed motor.
- (d) The sizes normally available are from 1/8 Hp to 10 Hp.
- (e) Capacitor-start motors are usually more expensive than split-phase motors.
- (f) They may be obtained as a single voltage or dual-voltage motor.
- (g) Single voltage motors have a starting winding and one running winding. Dual voltage motors have a starting winding and two running windings.
- (h) It has many applications for more difficult starting loads. Examples listed are air compressors, pumps, blowers, feed grinders, conveyors, and power tools.

Transparency No. 8

- (i) The wiring diagram for a capacitor-start, single voltage motor is illustrated here. Note the capacitor and starting switch in the starting winding.

The windings on a capacitor-start, dual voltage motor may be identified with the continuity test lamp as was discussed for the split-phase motor.

Transparency No. 9

- (j) The wiring diagrams for a capacitor-start, dual voltage motor, when operating on 120 volts, are shown in this transparency. (The running windings are wired in parallel).

Transparency No. 10

- (k) The wiring diagrams for a capacitor-start, dual voltage motor, when operating on 240 volts, are illustrated here. (The running windings are wired in series).

Transparency No. 11

Repulsion-Start Motor

- (a) This motor is used for starting heavy loads. The high starting torque is provided by a wound rotor and brushes.

- (b) It has low starting current requirement and will draw 2 to 4 times its normal running current when starting.
- (c) It is considered a constant speed motor.
- (d) It is usually available as a dual voltage motor.
- (e) The sizes normally available are from 1/6 Hp to 20 Hp.
- (f) It is a heavy duty motor and is more expensive than the split-phase or capacitor-start motor.
- (g) It has many applications for heavy starting loads. Examples listed are feed mills, large blowers, silo unloaders, elevators, and deep-well pumps.

Transparency No. 12

- (h) The wiring diagrams for 120 volt and 240 volt operation are illustrated in this transparency. For 120 volt operation, the windings are wired in parallel. For 240 volt operation, the windings are wired in series.

The direction of rotation of the motor shaft may be changed by moving the brush-ring holder position as illustrated.

Transparency No. 13

Universal Motor

- (a) This motor is a series motor and can be operated on A.C. or D.C. current.
- (b) It is designed for intermittent use and has a short life when compared to the life of the other motors studied.
- (c) Universal motors are usually small in size, but may be obtained in sizes from 1/150 Hp to 2 Hp.
- (d) This is a variable speed motor, depending upon the load.
- (e) This motor has a high starting torque and requires a high starting current.
- (f) It is normally used for portable tools and portable appliances.

Shaded-Pole Motor

- (a) This is a small, single-phase motor that operates on A.C. current.
- (b) It has a low starting torque and its efficiency is low.
- (c) Available in sizes from 1/20 Hp to 1/6 Hp.
- (d) It is simply constructed and is used for very light loads such as small fans, blowers, and circulating pumps on evaporative water coolers.

Transparency No. 14

- (e) The design and windings of the universal motor and the shaded-pole motor are illustrated in this transparency.

Transparency No. 15

Three-Phase Motor

- (a) This motor is of simple construction and is operated only on three-phase A.C. current.
- (b) It has medium to high starting torque.
- (c) This motor may be obtained with the designation of low, normal, or high starting current requirement.
- (d) Its design provides for "self-starting" and includes no starting mechanism.
- (e) The three-phase motor is a constant speed motor.
- (f) It is available in sizes from 1/3 Hp. to several hundred Hp.
- (g) It is primarily used on large equipment.
- (h) The sizes 1 Hp and larger are lower in cost than single-phase motors.

Transparency No. 16

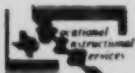
- (1) Illustrated here are the wiring diagrams of a three-phase motor. To reverse the direction of rotation, any two of the motor leads may be interchanged.

References:

1. Texas Education Agency, "Electric Motor Lesson Plans For Production Agriculture", Vocational Instructional Services, Texas A&M University, College Station, Texas.
2. Henderson, G.E., "Farm Electric Motors", Vocational Instructional Services, Texas A&M University, College Station, Texas.
3. Hamilton, J.R., Using Electricity On The Farm, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1959.
4. AAVIM, "How Electric Motors Start and Run", Vocational Instructional Services, Texas A&M University, College Station, Texas.

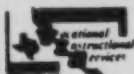
ADVANTAGES OF ELECTRIC MOTORS

1. INEXPENSIVE TO OPERATE
2. ALWAYS READY TO WORK
3. HIGHLY EFFICIENT
4. LONG LIFE
5. SIMPLE TO OPERATE
6. SAFE
7. MINIMUM SERVICING
8. QUIET OPERATION
9. COMPACT AND AUTOMATICALLY CONTROLLED
10. ADAPTABLE

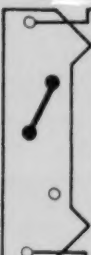


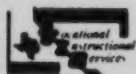
FACTORS IN SELECTING ELECTRIC MOTORS

- ★ TYPE OF POWER AVAILABLE
- ★ SIZE OF MOTOR (HORSEPOWER)
- ★ STARTING LOAD REQUIREMENT
- ★ SPEED REQUIRMENT
- ★ TYPE OF BEARINGS
- ★ TYPE OF BASE OR MOUNT
- ★ ENVIRONMENT



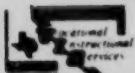
MOTOR NAME PLATE

A. C. 1 PH.		● MOTOR TYPE FJ									
THERMOGUARD TYPE			A								
HP 1/2		FRAME 186									
R. P. M. 1725		C. Y. C. 60									
C 40	HOURS CONT 40	LOCKED KV-A									
STYLE 1180016-B			SERIAL GO								
 <table border="1"> <tr><td>VOLTS</td></tr> <tr><td>120</td></tr> <tr><td>AMPS</td></tr> <tr><td>7.0</td></tr> </table>		VOLTS	120	AMPS	7.0	 <table border="1"> <tr><td>VOLTS</td></tr> <tr><td>240</td></tr> <tr><td>AMPS</td></tr> <tr><td>3.5</td></tr> </table>		VOLTS	240	AMPS	3.5
VOLTS											
120											
AMPS											
7.0											
VOLTS											
240											
AMPS											
3.5											
TO REVERSE, INTERCHANGE RED AND YELLOW LEADS.											
OPEN											
ELECTRIC CORP.											
30248		● MADE IN U. S. A.									

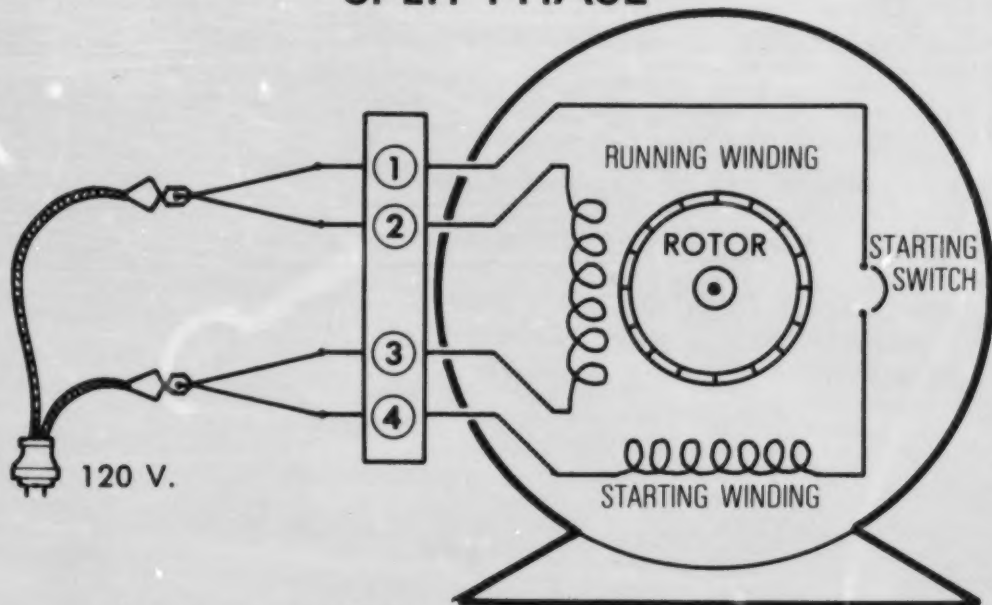


SPLIT-PHASE MOTOR

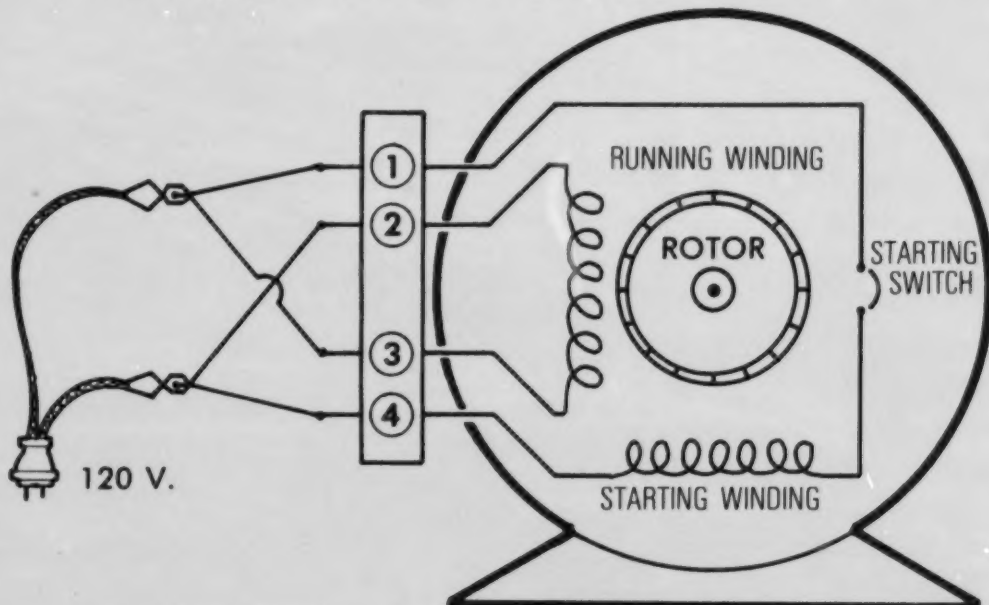
- FOR EASY STARTING LOADS
- HIGH STARTING CURRENT —
6-8 TIMES FULL LOAD CURRENT
- SIZES AVAILABLE—
1/20 HP TO 3/4 HP
- CONSTANT SPEED—
SINGLE VOLTAGE
- INEXPENSIVE—
SIMPLE CONSTRUCTION
- HAS STARTING WINDING & STARTING SWITCH
- APPLICATIONS—
EMERY WHEEL - SEED CLEANER
BENCH SAW - WASHING MACHINE



SPLIT PHASE



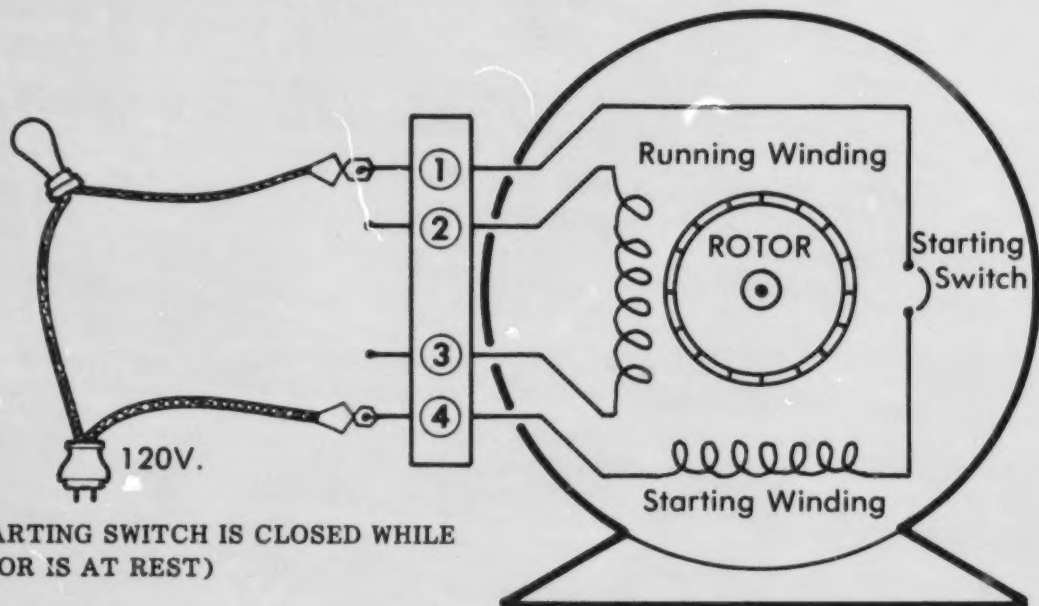
CIRCUIT DIAGRAM FOR A SPLIT-PHASE SINGLE-VOLTAGE MOTOR OPERATING IN ONE DIRECTION.



CIRCUIT DIAGRAM FOR A SPLIT-PHASE SINGLE-VOLTAGE MOTOR OPERATING IN OPPOSITE DIRECTION.

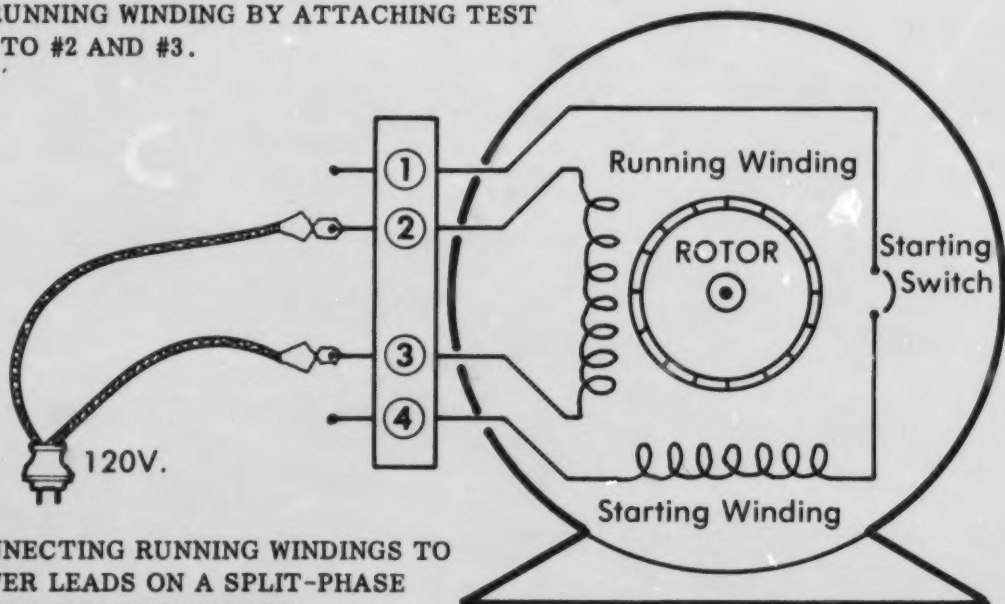


TESTING WINDINGS

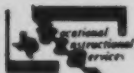


(STARTING SWITCH IS CLOSED WHILE MOTOR IS AT REST)

TESTING STARTING AND RUNNING WINDINGS ON A SPLIT-PHASE SINGLE-VOLTAGE MOTOR. TEST STARTING WINDING AS SHOWN. TEST RUNNING WINDING BY ATTACHING TEST LEADS TO #2 AND #3.



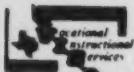
CONNECTING RUNNING WINDINGS TO POWER LEADS ON A SPLIT-PHASE SINGLE-VOLTAGE MOTOR.



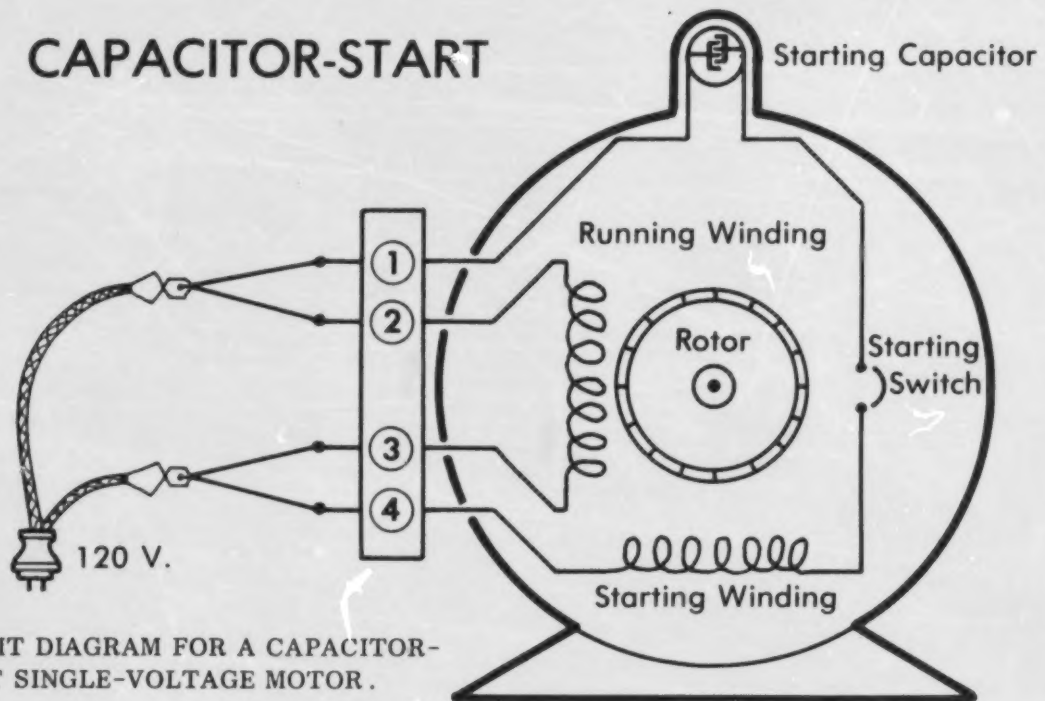
CAPACITOR-START MOTORS

- 1 HAVE A CAPACITOR IN THE STARTING WINDING
- 2 USED FOR DIFFICULT STARTING LOADS
- 3 MEDIUM STARTING CURRENT—
3-6 TIMES FULL LOAD CURRENT
- 4 CONSTANT SPEED
- 5 SIZES—
1/8 HP TO 10 HP
- 6 25-40% MORE EXPENSIVE THAN
SPLIT PHASE MOTORS
- 7 SINGLE OR DUAL VOLTAGE-
120/240 VOLTS
- 8 HEAVY DUTY APPLICATIONS---

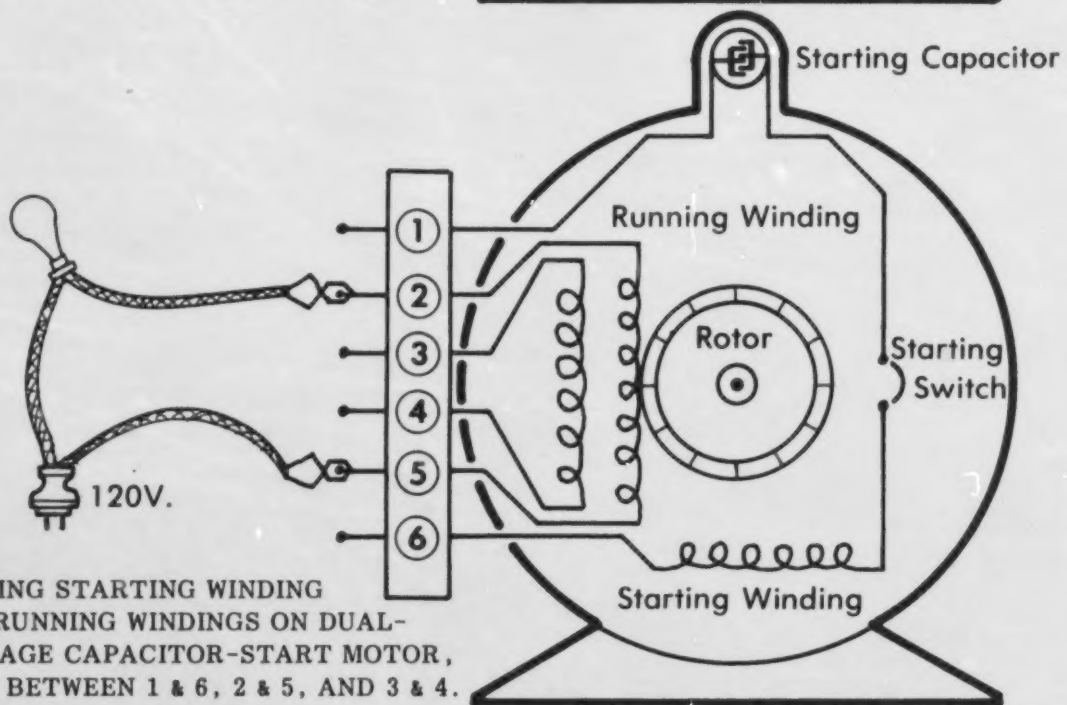
air compressors	pumps
feed grinders	blowers
power tools	conveyors



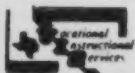
CAPACITOR-START



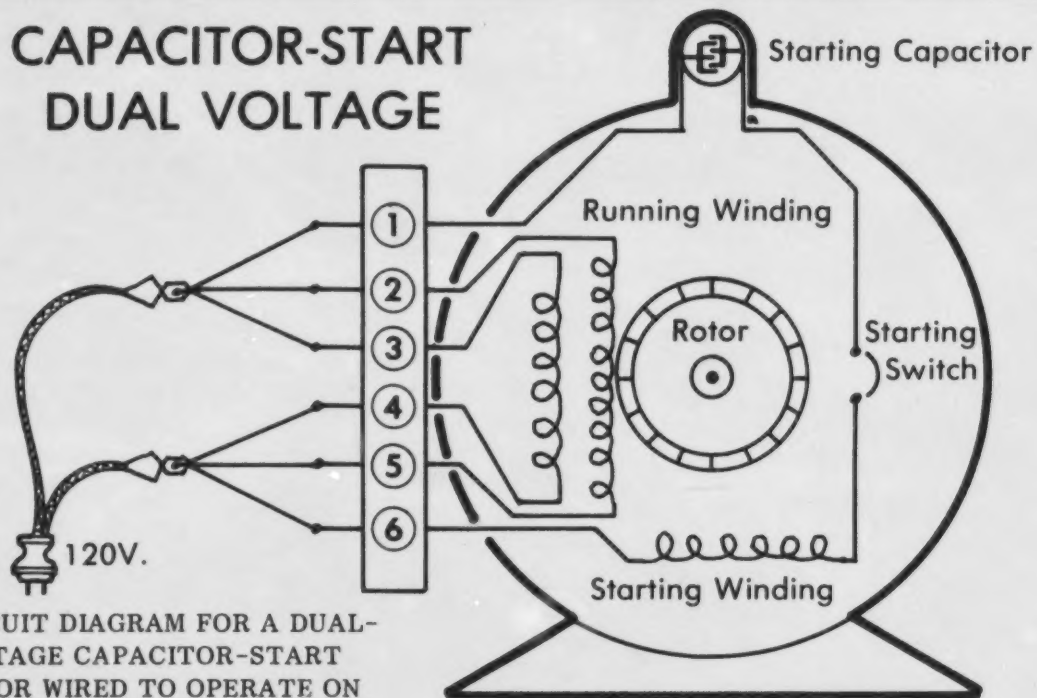
CIRCUIT DIAGRAM FOR A CAPACITOR-START SINGLE-VOLTAGE MOTOR.



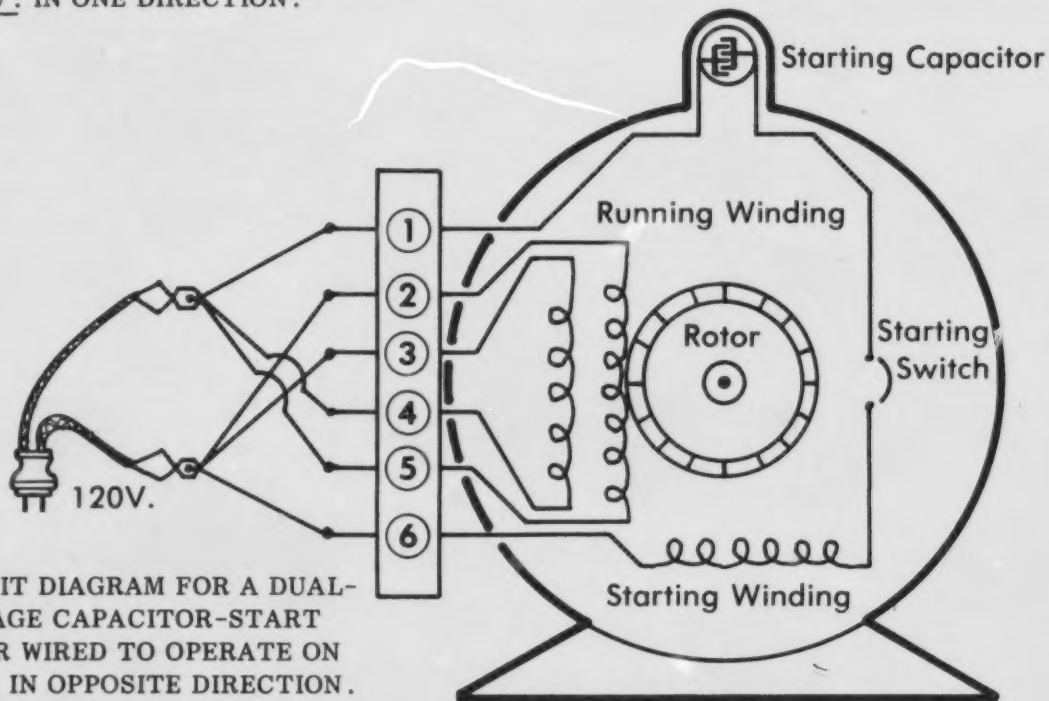
TESTING STARTING WINDING AND RUNNING WINDINGS ON DUAL-VOLTAGE CAPACITOR-START MOTOR, TEST BETWEEN 1 & 6, 2 & 5, AND 3 & 4.



CAPACITOR-START DUAL VOLTAGE

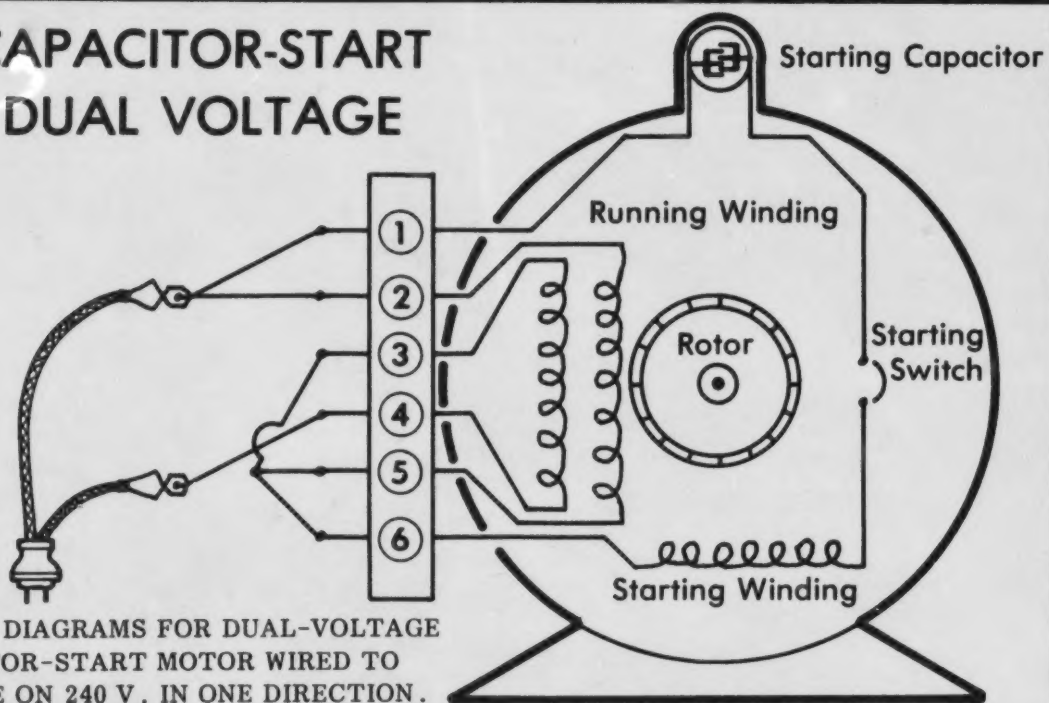


CIRCUIT DIAGRAM FOR A DUAL-VOLTAGE CAPACITOR-START MOTOR WIRED TO OPERATE ON 120 V. IN ONE DIRECTION.

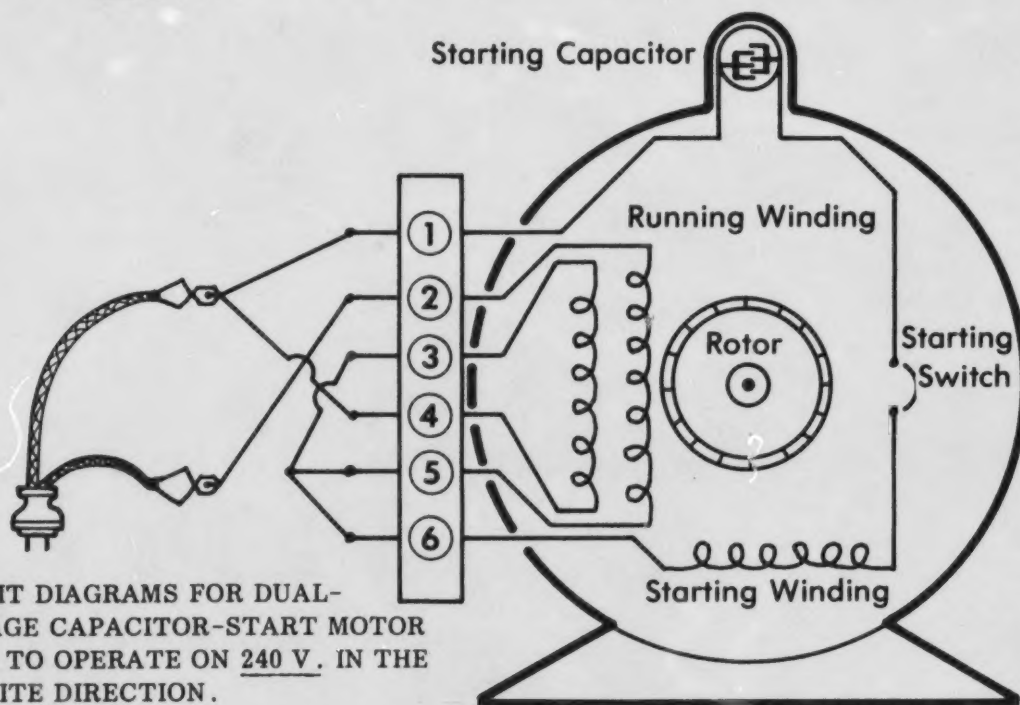


CIRCUIT DIAGRAM FOR A DUAL-VOLTAGE CAPACITOR-START MOTOR WIRED TO OPERATE ON 120 V. IN OPPOSITE DIRECTION.

CAPACITOR-START DUAL VOLTAGE



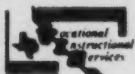
CIRCUIT DIAGRAMS FOR DUAL-VOLTAGE
CAPACITOR-START MOTOR WIRED TO
OPERATE ON 240 V. IN ONE DIRECTION.



CIRCUIT DIAGRAMS FOR DUAL-VOLTAGE
CAPACITOR-START MOTOR
WIRED TO OPERATE ON 240 V. IN THE
OPPOSITE DIRECTION.

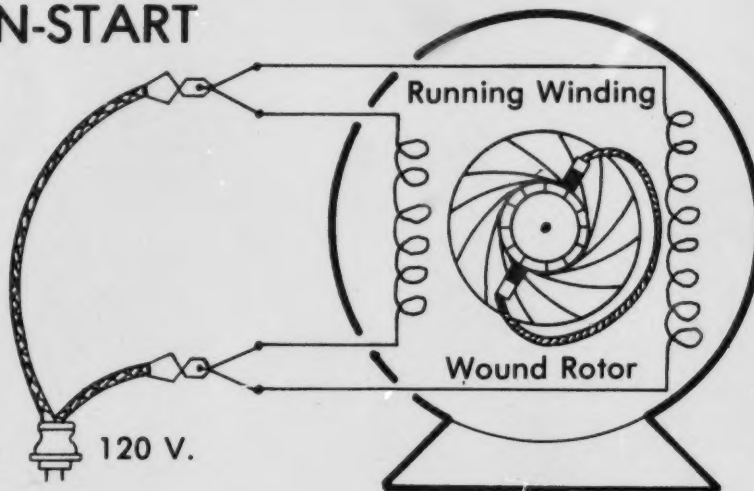
REPULSION-START MOTOR

- ➔ USED FOR HEAVY STARTING LOADS
- ➔ USES WOUND ROTOR AND BRUSHES FOR STARTING
- ➔ HIGH STARTING TORQUE—
LOW STARTING CURRENT—
2-4 TIMES FULL LOAD CURRENT
- ➔ CONSTANT SPEED
- ➔ USUALLY DUAL VOLTAGE—
120/240/ VOLTS
- ➔ SIZES—
1/6 HP TO 20 HP
- ➔ HEAVY DUTY—
MORE EXPENSIVE TYPE MOTOR
- ➔ APPLICATIONS---
large blowers compressors
silo unloaders feed mills
deep well pumps elevators

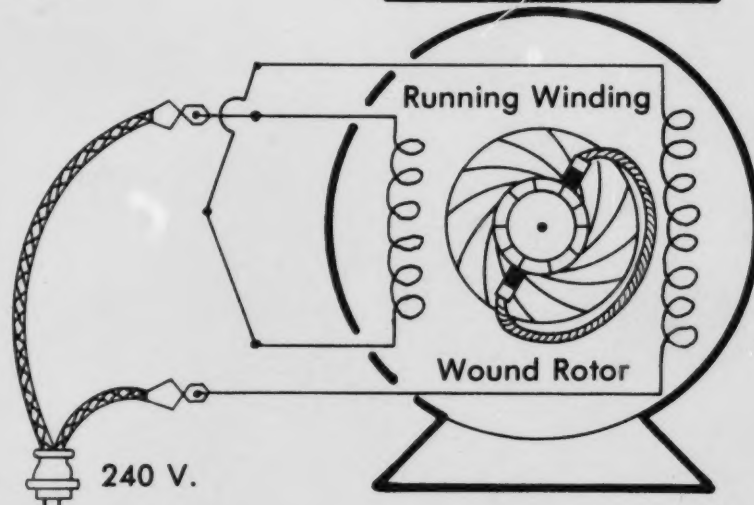


REPULSION-START

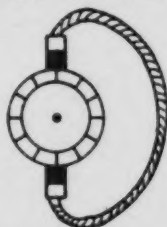
CIRCUIT DIAGRAM FOR
A DUAL-VOLTAGE
REPULSION-START
MOTOR WIRED FOR
120 V. OPERATION.



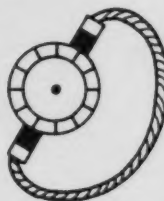
CIRCUIT DIAGRAM FOR
A DUAL-VOLTAGE
REPULSION-START
MOTOR WIRED FOR
240 V. OPERATION.



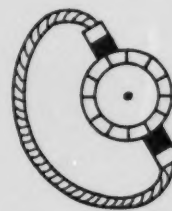
(DEAD CENTER)
Motor will not start



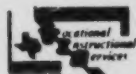
(CLOCKWISE DIRECTION)



(COUNTER CLOCKWISE
DIRECTION)



SETTING OF BRUSH RING ON REPULSION-START MOTOR TO DETERMINE
DIRECTION OF ROTATION.

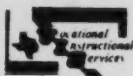


UNIVERSAL MOTOR

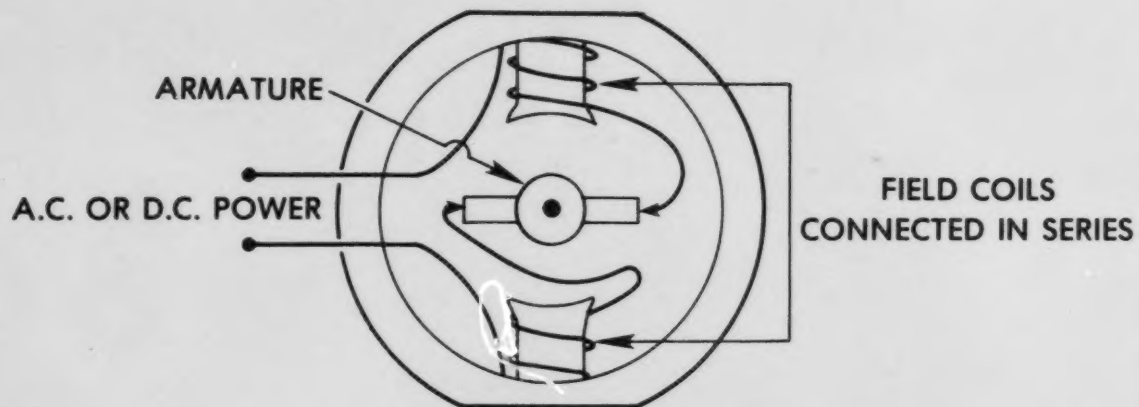
1. OPERATES ON AC OR DC
2. SHORT LIFE - INTERMITTENT USE
3. 1/150 TO 2 HORSEPOWER
4. SPEED DEPENDS UPON LOAD
5. HIGH STARTING TORQUE - HIGH STARTING CURRENT
6. USED FOR PORTABLE TOOLS AND APPLIANCES

SHADED-POLE MOTOR

1. SMALL SINGLE-PHASE AC MOTOR
2. LOW STARTING TORQUE - LOW EFFICIENCY
3. 1/20 TO 1/6 HORSEPOWER
4. SIMPLE CONSTRUCTION - LIGHT DUTY SUCH AS
SMALL FANS, BLOWERS, ETC.

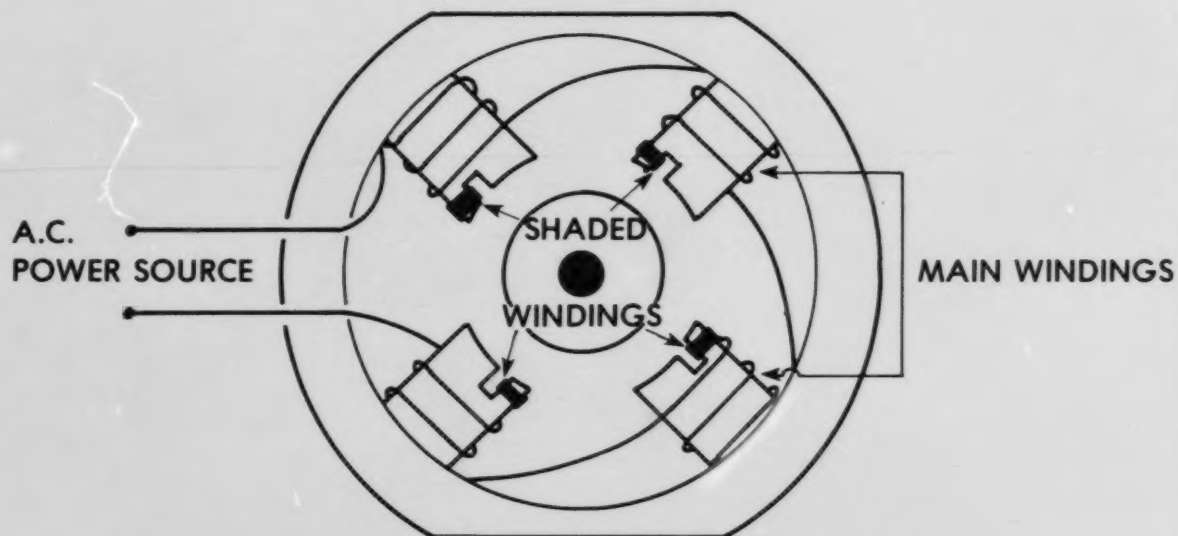


UNIVERSAL MOTOR



SERIES CONNECTION OF A UNIVERSAL MOTOR

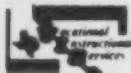
SHADED-POLE MOTOR



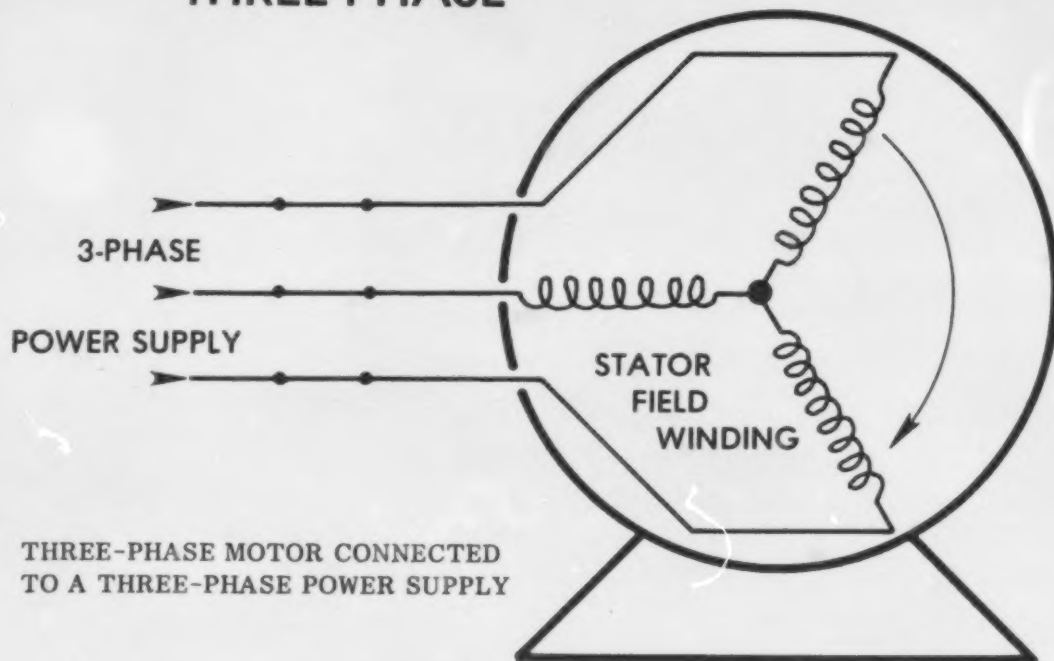
FOUR - POLE, SHADED - POLE MOTOR SHOWING
MAIN WINDINGS AND SHADED WINDINGS

THREE-PHASE MOTOR

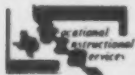
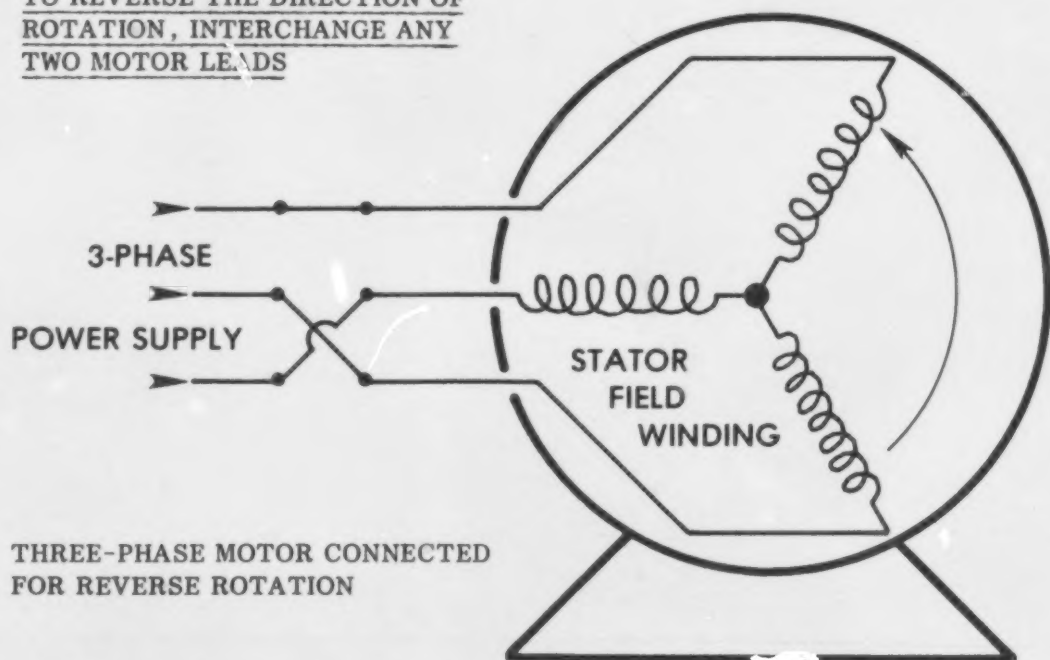
1. SIMPLE CONSTRUCTION
2. USED ON THREE-PHASE ALTERNATING CURRENT POWER SOURCE ONLY
3. MEDIUM TO HIGH STARTING TORQUE
4. LOW, NORMAL AND HIGH STARTING CURRENT
5. "SELF-STARTING"-NO STARTING MECHANISM REQUIRED
6. CONSTANT SPEED MOTOR
7. SIZES - 1/3 HP TO SEVERAL HUNDRED HP
8. USED PRIMARILY ON LARGE EQUIPMENT
9. SIZES 1 HP AND LARGER ARE LOWER IN COST THAN SINGLE-PHASE MOTORS



THREE-PHASE



TO REVERSE THE DIRECTION OF
ROTATION, INTERCHANGE ANY
TWO MOTOR LEADS



AGRICULTURAL MECHANICS

Unit A: Farm Electricity

Topic 5: Care and Maintenance of Electric Motors

Suggested Procedure and Activities: During the discussion and explanation of the information, the transparencies may be utilized and the teacher may demonstrate how to disassemble, clean, and reassemble a motor.

1. Protection of Electric Motors

Transparency No. 1

Overload Protection

An electric motor should be protected from performing more work than it is designed to perform. If the motor is overloaded, the ampere flow is likely to become great enough to damage the motor.

Overload can be caused by (1) motor size too small for the job, (2) improper wiring and low voltage, (3) improper installation, (4) belts too tight, (5) improper lubrication, or (6) the entry of foreign materials (dust, water, or oil) into the motor.

Overload protection may be provided by (1) proper fusing of the motor circuit, (2) built in protection in the motor, (3) manual reset switch control, or (4) special motor starter (current-limiting starter).

Transparencies Nos. 2a and 2b

Proper Installation

The installation of an electric motor should be made so that a minimum of vibration will occur. It is also very important to make the installation so that proper alignment will result. Misalignment will cause wear and may also be a factor in overloading a motor.

Transparency No. 3

Prevent Friction

A minimum of friction in the mechanical operation of a motor is necessary to prevent excessive wear and possible overloading of the motor.

The manufacturer's recommendations for lubrication intervals should be closely followed.

A high-quality lubricant should be used for motor lubrication.

Motors with sleeve bearings require mounting so that the shaft is horizontal and level for proper lubrication.

Worn bearings should be replaced and the alignment of motor, drive, and equipment should be true.

Transparency No. 4

Protect From Dust

The accumulation of dust in and on a motor acts as insulation and may cause excessive heating of the motor.

Dust and other foreign materials counteract lubrication and will cause friction and wear in the bearings and shaft.

The dust should be wiped from motors at regular intervals. Air under pressure (not more than 40 pounds per square inch pressure) should be used to blow dust from the windings at regular intervals. Excessive lubrication should be avoided to prevent excessive accumulation of dust. Dust seals and oil caps on motors should be in good condition and kept closed.

Transparency No. 5

Protect From Moisture

Moisture is a conductor of electricity. Dry insulation confines the current to the correct path. When insulation is wet, the current may not be properly confined and a "short" may result.

Motors may be protected from moisture by well-ventilated enclosures.

A wet motor should be dried thoroughly before it is used. Some type of heat and a fan may be applied to the motor to dry it thoroughly.

Transparency No. 6

Protect From Excessive Oil

Too much oil or grease can be harmful to an electric motor. Damage from too much oil may result from the accumulation of extra dust or from the deterioration of insulation within the motor.

The manufacturer's recommendations for lubricating a motor should be closely followed.

To remove excessive oil, a non-inflammable solvent and a paint brush may be used.

2. Maintenance of Electric Motors

550

Disassembly of Split-Phase Motor

- (a) Mark the end plates and frame with a center punch or other marking device to insure the proper reassembly of the motor.
- (b) Remove the through bolts or screws and remove the end plate. (A light tap may be needed to loosen the end plate).
- (c) Remove the rotor (center shaft).
- (d) Notice the wiring connections on the terminal wiring plate and the starting switch.
- (e) Identify the following parts:

Transparency No. 7

- | | |
|---------------|--------------------------|
| 1. Motor base | 6. Centrifugal mechanism |
| 2. End plates | 7. Starting switch |
| 3. Bearings | 8. Oil or grease rings |
| 4. Rotor | 9. Stator windings |
| 5. Fan | 10. Protective device |

Cleaning and Checking Split-Phase Motor

- (a) Clean motor and motor parts, using a non-inflammable cleaning solvent and paint brush.
- (b) Disconnect the wiring leads from the terminal wiring plate. Use a continuity test lamp to determine which two leads complete a circuit in the stator windings. Two separate windings should be identified - a running winding and a starting winding. (The running winding will be a heavier wire than the starting winding wire).
- (c) Check each winding for a "short" by connecting one lead of the continuity test lamp to one end of a winding. With the continuity test lamp energized, touch the other lead of the lamp to the motor frame. If the light burns, it indicates a "short" between the winding and the metal frame. Test the other winding in the same manner. If a short is indicated, the motor should be rewound or replaced.

Reassembly of Split-Phase Motor

- (a) Connect wiring leads to the proper terminals on the terminal wiring plate.
- (b) Replace rotor.
- (c) Replace end plate, being careful to replace it in its original position. (The center punch marks were made for this purpose).
- (d) Replace through bolts and tighten evenly. Determine that the rotor turns freely after the through bolts have been tightened.
- (e) Energize the motor and check its operation.

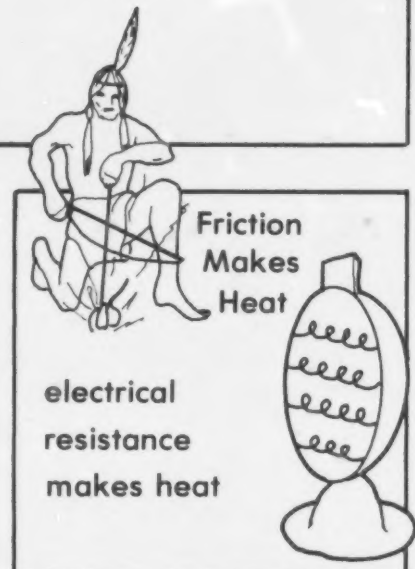
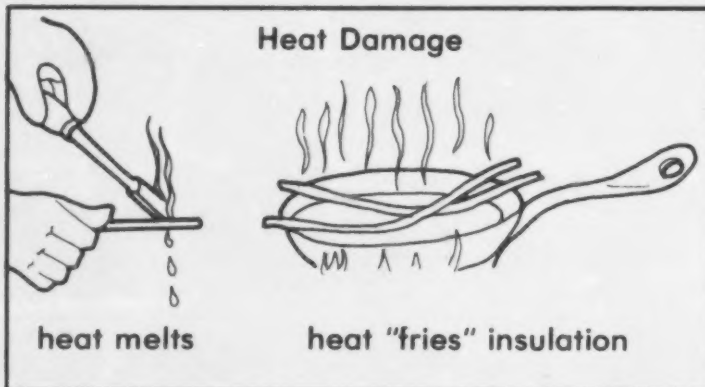
References:

- 1. Texas Education Agency, "Electric Motors Lesson Plans for Production Agriculture", Vocational Instructional Services, Texas A&M University, College Station, Texas.
- 2. Hamilton, J.R., Using Electricity On The Farm, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1959.
- 3. AAVIM, "How Electric Motors Start and Run", Vocational Instructional Services, Texas A&M University, College Station, Texas.

OVERLOAD



A MOTOR WORKED BEYOND ITS HORSEPOWER CAPACITY IS SURE TO BREAKDOWN AS AN OVERLOADED HORSE WILL

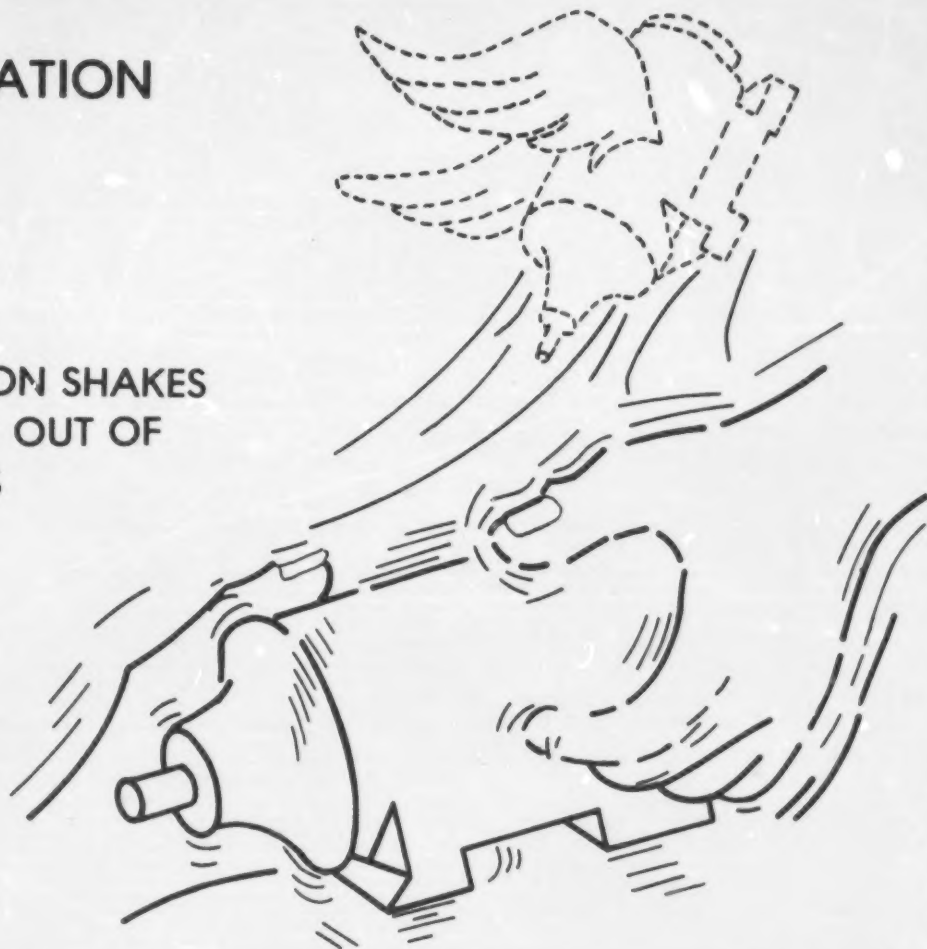


HOW TO CORRECT IT:

1. Check your electrical overload protection to see it is operative.
2. See that overload protection is proper size or capacity.
3. Use the proper motor horsepower for the load or adjust the loading rate to not exceed the motor capability.

VIBRATION

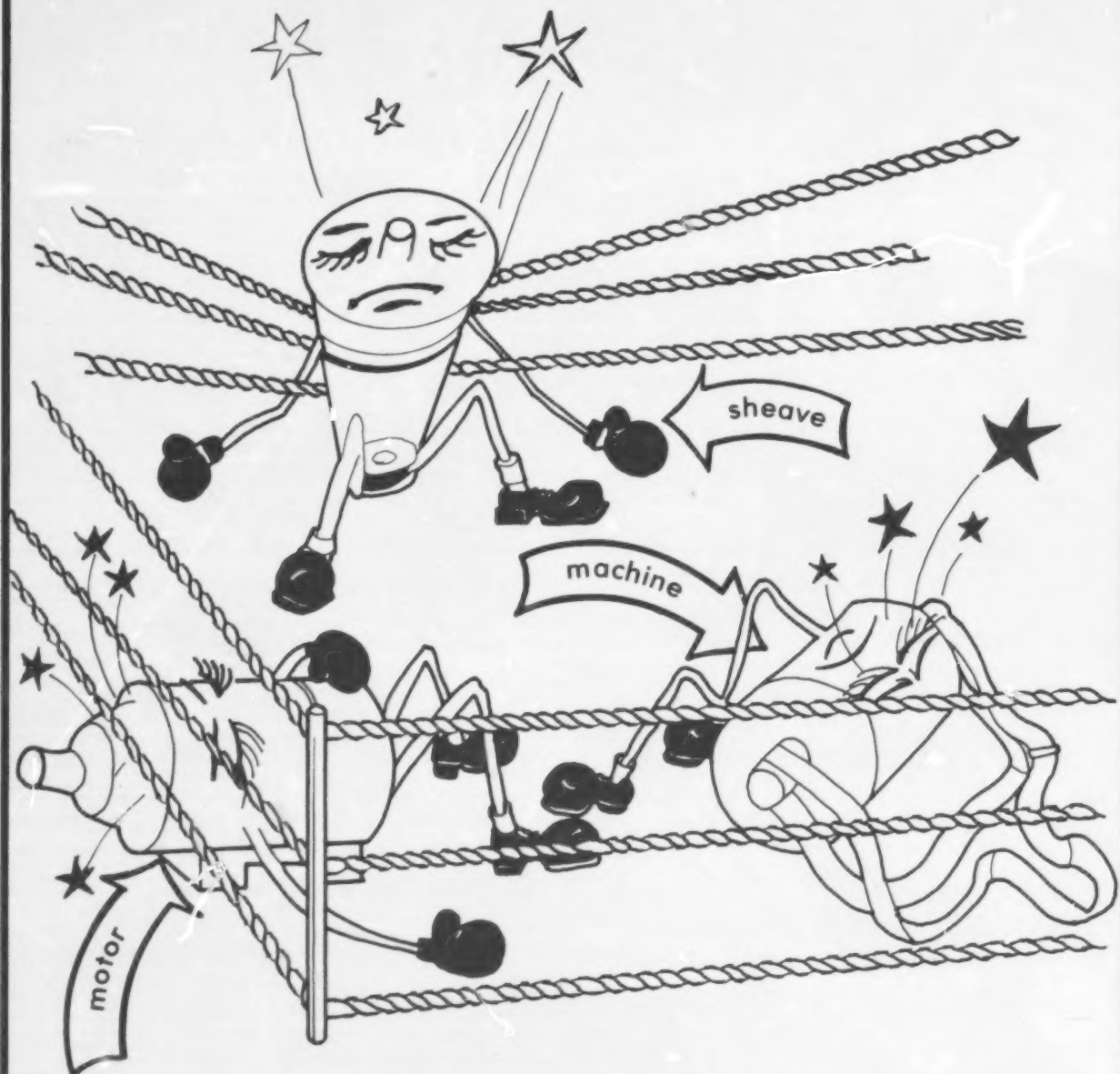
VIBRATION SHAKES
THE LIFE OUT OF
MOTORS



HOW TO CORRECT IT:

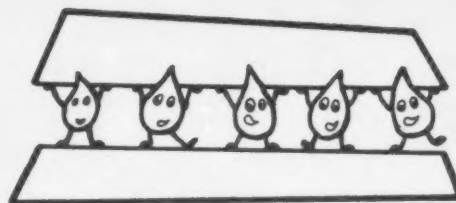
1. Tighten all mounting bolts.
2. Check for solid foundation.
3. Check bearings for looseness.
4. Disengage vibrating motor from machine and check both for mounting.

MISALIGNMENT

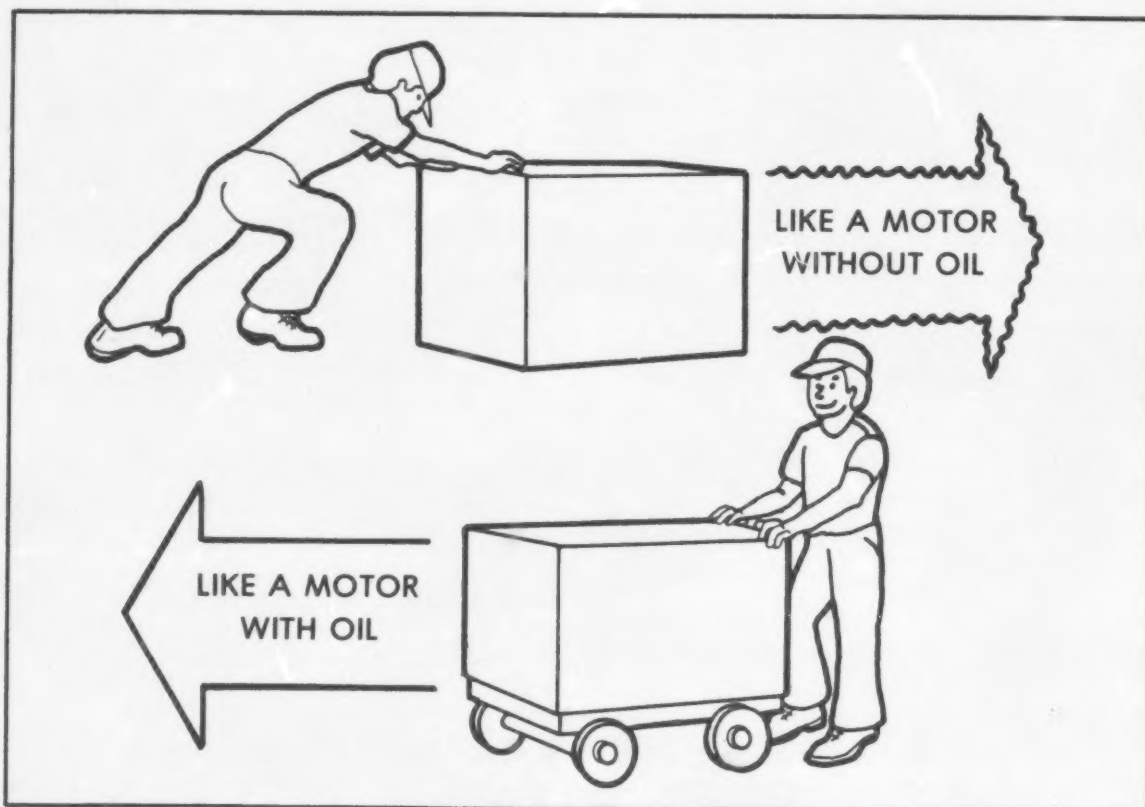


Once MISALIGNMENT starts 'em fighting each other----
----the only question is: Which will go FIRST?

FRICITION



OIL REDUCES FRICTION



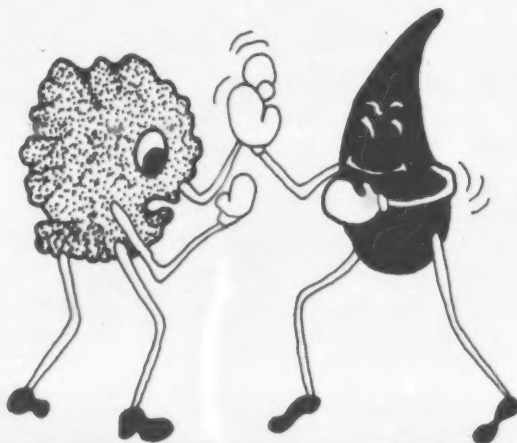
HOW TO CORRECT IT:

1. Pay strict attention to motor manufacturer's lubrication instructions.
2. Use top quality non-detergent oil or grease.
3. Replace worn bearings.

DUST



DUST ON ITS WINDINGS "BLANKETS" A MOTOR
WITH A LAYER OF INSULATION



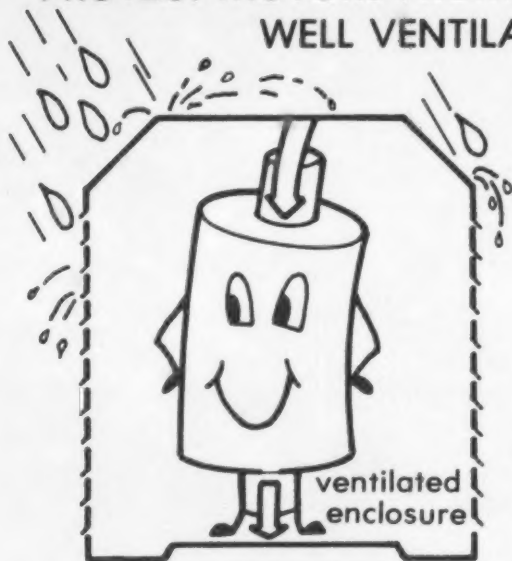
DUST FIGHTS
LUBRICATION

HOW TO CORRECT IT:

1. Wipe motor off at regular intervals.
2. Blow dust out of windings with no more than 40 lbs. pressure.
3. See that oil filter caps are always closed and dust seals are in good condition.
4. Do not overlubricate.

MOISTURE

PROTECT MOTORS FROM MOISTURE BY CONSTRUCTING
WELL VENTILATED ENCLOSURES



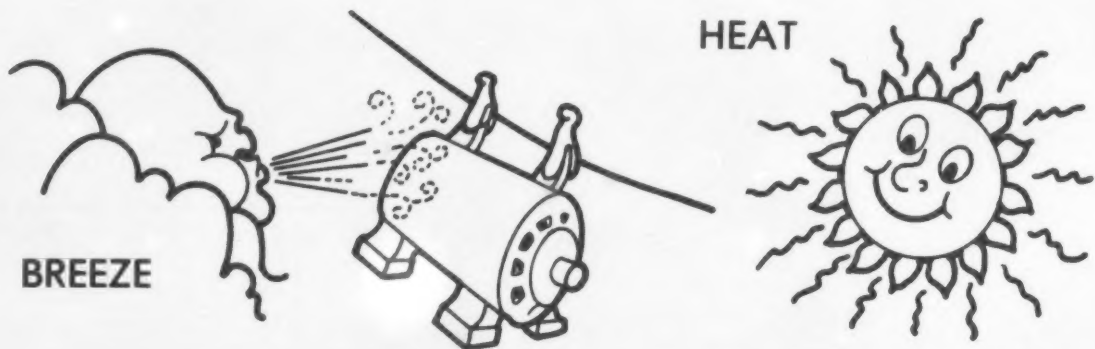
Dry insulation handles
voltage easily



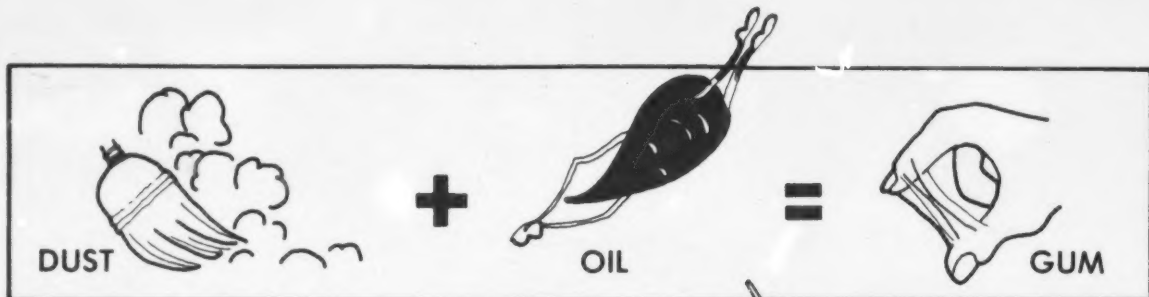
When wet, voltage may be
too much to hold

WAYS TO DRY OUT MOTORS:

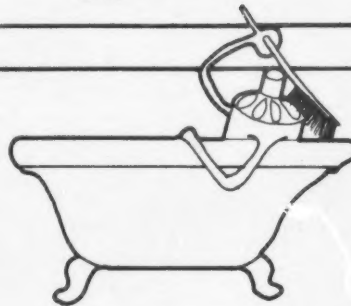
1. Use heat from portable heaters, oven, or resistance coils.
2. Use a breeze from an electric fan. Combine fan with heater if possible.



STRAY OIL



SOMETIMES A MOTOR
NEEDS A BATH. . .



HOW TO CORRECT IT:

1. Use paint brush and a non-inflammable solvent to brush and clean oil away.
2. Follow manufacturer's instructions for greasing motors.

(Beware of overlubrication)



**OIL IS QUICK TO
ATTACK INSULATION
WHEN IT GETS TO IT!**

SPLIT-PHASE MOTOR PARTS

1. MOTOR BASE
2. END PLATES
3. BEARINGS
4. ROTOR
5. FAN
6. SHAFT
7. CENTRIFUGAL MECHANISM
8. STARTING SWITCH
9. OIL OR GREASE FITTINGS
10. STATOR WINDINGS
11. PROTECTIVE DEVICE

AGRICULTURAL MECHANICS

UNIT B: Agricultural Power - Small Gas Engines

TOPIC 1: Basic Principles of a Four-Cycle and Two-Cycle Internal Combustion Engine

Suggested Procedures and Activities: The use of the two types of engines and the transparencies may be helpful in presenting the lesson.

1. The Importance of Four-Cycle and Two-Cycle Internal Combustion Engines

The small internal combustion engine is a very important source of power on the farm. It is estimated that over 6,000,000 small engines are produced annually in the United States. The total number of single-cylinder engines in the United States may exceed 70,000,000.

Transparency No. 1

Small engines are adaptable to many kinds of jobs because they are:

- Lightweight
- Portable
- Compact
- Economical on fuel use
- Easy to service and repair
- Air-cooled
- Source of power for small equipment

Transparency No. 1

The following equipment may be powered by small engines:

Mowers	Brush cutters
Chain saws	Rotary tillers
Conveyors	Irrigation pumps
Post hole diggers	Sprayers
Elevators	Concrete vibrators
Small feed grinders	Concrete surfacers
Air compressors	Small tractors
Outboard boats	Generators

Small engines used to power this type of equipment are known as internal combustion reciprocating engines. A combustible mixture of petroleum products and air in the piston chamber (cylinder) is burned to form heat which is the source of power. The shaft is turned as pressure is applied to the top of the piston, forcing it down as the air-fuel mixture burns and expands in the cylinder. The piston is connected to a connecting rod which is connected to the crankshaft.

2. Types of Small Engines

Transparency No. 2

- a. Four-Stroke Cycle Engines - There are two complete revolutions of the crankshaft for each power stroke of the piston or a complete cycle of the engine. A complete cycle consists of the following four strokes in the cylinder which are:

Intake Stroke - As the piston moves downward, a mixture of fuel and air are drawn into the cylinder; the intake valve is open and the exhaust valve closed.

Compression Stroke - The intake and exhaust valves remain closed on this stroke. The upward movement of the piston compresses the fuel-air mixture in the cylinder.

Power Stroke - Both valves remain closed on this stroke. The fuel-air mixture is ignited by an electrical spark. The explosion of the fuel mixture pushes the piston down.

Exhaust Stroke - As the piston moves up, burned gases are forced out of the cylinder through the open exhaust valve. The exhaust valve closes at the end of the stroke and the intake valve opens as the next cycle begins.

Transparency No. 3

- b. Two Stroke Cycle Engines - The piston makes two strokes and the crankshaft turns one complete revolution in completing a cycle from power stroke to power stroke. The strokes are:

Compression Stroke - A partial vacuum is created in the crankcase, permitting the fuel-air mixture to enter as the piston moves upward. The exhaust and inlet ports (openings) are sealed off on the compression stroke by the piston. At the end of this stroke, the spark ignites the charge forcing the piston down.

Exhaust Stroke - The fuel-air mixture in the crankcase enters the combustion chamber (cylinder) through the inlet port. Gases from burned fuel escape through the exhaust port at the same time new fuel enters the cylinder. The inlet from the carburetor is closed and the two ports are open on the downward stroke.

- c. Major Differences in the Four-Cycle and Two-Cycle Engines

Four Cycle

Has regular intake and exhaust valves

Oil is used entirely as a lubricant

Two Cycle

Piston or thin piece of metal over an opening (reed valve) serves as a valve.

Oil is mixed with gasoline and used as a fuel and lubricant.

Four Cycle

Two revolutions of the crankshaft are one cycle.

Crankcase contains only a lubricant.

Four strokes of the piston complete one cycle.

Has valves lifters, valve springs and a camshaft.

More difficult to handle on very small equipment.

May start more easily than two-cycle. Burned and unburned gases are not likely to mix.

Less power produced per unit of weight because there is a power stroke every two revolutions of the crankshaft.

Easy to lubricate. Fuel is separated from the lubricating oil.

Costs more than two-cycle engine.

Two Cycle

One revolution of the crankshaft is a cycle.

Crankcase contains a fuel that also serves as a lubricant.

Two strokes of the piston complete one cycle.

Has no camshaft, valve lifters or valve springs.

Less difficult to handle on small hand equipment.

More difficult to start than four-cycle.

More power produced per unit of weight. This is important in using light equipment.

Lubricating oil is mixed with engine fuel, resulting in a less efficient job of engine lubrication.

Cost is usually less due to simpler construction.

d. Methods used to Distinguish Between a Four-Cycle and Two-Cycle Engine

Check the operator's manual for crankcase capacity or the kind of oil to use. If the crankcase capacity is discussed, the engine is a four-cycle. The mixing of oil and gas would identify the engine as a two-cycle.

Check to see if the engine has an oil sump (place to add oil or a place to drain the oil). A four-cycle engine has a sump a two-cycle does not.

Check to determine whether or not the engine has an exhaust muffler at the end of the cylinder, and if it does, it is a four cycle engine. The muffler is located in the center of the cylinder on a two cycle engine.

Check the compression by disconnecting the spark plug wire, mark the flange of the starter pulley and crank the engine by hand. On a four-cycle engine, resistance is felt on every other revolution. Resistance is caused by compression on each revolution of a two-cycle engine.

3. Fundamentals of Engine Operation

The primary functions of engine operation are: compression, carburetion and ignition. Secondary functions are: cooling and lubrication.

Transparencies Nos. 4 and 5

Compression - Compression takes place in a small engine when the piston completes its downward stroke and starts back on the upward stroke, with all valves or parts closed or in the process of being closed. The compression stroke raises the temperature of the fuel making it more explosive.

In order for the fuel-air mixture to be compressed by the piston in the top of the cylinder, no leakage must appear between the piston and cylinder wall. Compression rings are fitted in a groove near the top of the piston so that they may serve the following functions:

Exert pressure on the cylinder wall to compress the fuel-air mixture in a small space.

Scrape the oil back into the crankcase and away from the combustion chamber to keep it from being burned.

Each cylinder has a perforated oil ring located below the compression ring or rings. The perforations permit the oil to be spread evenly on the cylinder wall.

The amount of fuel-air mixture to be compressed in a cylinder depends on the piston displacement (space displaced by the piston in its up and down travel). The area of displacement depends on the size of bore and the length of stroke. The following formula is used to compute piston displacement in cubic inches:

$$\text{Piston displacement} = \frac{(\text{bore})^2}{4} \times \pi \times \text{stroke}$$

Example of a 2 inch bore and a 1 3/4 inch stroke:

$$\frac{2 \times 2}{4} \times 3.1416 \times 1 \frac{3}{4} = 5.5 \text{ cubic inches piston displacement}$$

Most small engines vary from 5:1 to 6:1 compression ratio. The ratio is a good comparison of the cylinder area, when the piston is at the bottom and at the top of the stroke. Generally, an engine with a high compression ratio has more power than one with low compression.

Valves are one of the most important parts of an engine. If a small four cycle engine is operating at 3000 rpm (revolutions per minute), the two valves are opening and closing in 1/50 of a second. Valves must seal well and withstand pressures up to about 500 pounds per square inch. The exhaust valve is damaged by heat more than any other part of the engine. Two-cycle engine valves (piston as a slide valve, reed valve and rotary valve) control mainly the openings from the carburetor to the crankcase. None of these valves are exposed to the same severe heat condition as is found in the four-cycle exhaust valve.

Transparencies Nos. 6 and 7

Carburetion - The major function of the carburetor is to atomize the fuel, (reduce to fine spray) mix air with the fuel, vaporize the fuel, and deliver the mixture to the combustion chamber (that portion of the cylinder where the fuel is burned).

The best operating mixture is 12 to 13 parts of air by weight to one part of gasoline. The carburetion function is basically the same in two-cycle and four-cycle engines. Air is mixed with the fuel to form a combustible mixture. Float and suction type carburetors are found on these two types of small engines. The venturi (narrow part of throttle pipe where accelerated air moves through this pipe causing fuel to be drawn through the nozzle and atomized) is found on carburetors for two-cycle and four-cycle engines. These two types of engines also have similar speed control, fuel mixture control (fuel air), choke, and air cleaner and breather parts.

These two major types of fuel systems are:

Gravity System - The fuel tank is located above the carburetor, thus permitting the fuel to flow by gravity into the carburetor bowl. A small air vent on the tank cap lets air into the tank as the fuel flows out.

Fuel is regulated at a constant level in the carburetor bowl by a float valve. As the fuel is burned in the cylinder, the carburetor float lowers, permitting the valve to open and let more fuel into the bowl. Many four-cycle engines have a sediment bowl located between the fuel tank and the carburetor.

Suction System - Fuel is drawn from the tank through a tube that is located below the carburetor. The suction created by the engine pulls gas from the fuel tank and a foot valve keeps the fuel from returning to the tank. This insures a tank full of fuel at all times.

The speed of a small engine is controlled by air vane and centrifugal type governors. A hand throttle may increase or decrease the tension on the throttle spring. The spring moves the flap which is attached on a hinge in the air current created by the fins of the flywheel. Increase in speed closes the butterfly valve (flat disk in the carburetor above the venturi) and a decrease in speed opens it. The centrifugal type controls the speed by a set of weights which move outward at a high speed and inward at a low speed. This outward and inward movement opens and closes the throttle.

Many small engine carburetors are equipped with an idle jet which opens into the air channel above the butterfly. The proportion of fuel to air is changed by this jet for an idling speed. An idle valve regulates the proper fuel-air mixture for idle speed operation. The air bleed system is widely used to control fuel-air mixtures in small engines. This system permits air to mix with the fuel before the fuel enters the air stream at the venturi (air enters the vent and mixes with fuel in the main fuel nozzle). As the engine speed increases, more air enters the vent, thus reducing the richness of the fuel mixture.

Many small engines are equipped with a second butterfly valve to increase the suction at the venturi. Closing or partial closing of this valve increases the amount of fuel in proportion to air. A richer mixture is required to start a cold engine because cold gasoline does not vaporize as readily as warm gasoline.

One of the most important ways to lengthen the life of a small engine is to use a good air cleaner and breather. If a small engine is running at 3600 rpm, it is estimated that it takes in 390 cubic feet of air per hour. Many small engines are used near the ground; therefore, there is a greater possibility for

contaminated air entering the carburetor than in larger engines. The two major types of air cleaners are:

Oil - saturated polyurethane and wire mesh filters remove dirt from the air as it is drawn through the filter.

Dry - type air filters contain an element made of paper, moss, foam rubber or felt. Dirt is caught in the element as the air passes through the filter into the engine.

Transparencies Nos. 8 and 9

Ignition - The ignition system furnishes a spark at the proper time which is strong enough to ignite the fuel-air mixture in the combustion chamber. Most engines function best when the spark occurs just before the piston reaches dead center on the power stroke.

There are two types of ignition systems used on internal combustion engines. They are:

Battery System - The battery system is used on garden tractors, lawn mowers and some stationary engines. Some small engines are equipped with battery and magneto ignition systems. The battery system consists of the following parts:

Battery	Timer
Ignition coil	Condenser
Spark plug	Cam
Battery cables	Breaker points
Ignition wires	Ignition switch

The battery system is also used on small engines that have starters and lights. Another way to identify the battery system is by the presence of a can-shaped ignition coil that is mounted some place on the engine.

Magneto Systems - Magnetos are used on most small engines where no electrical load is necessary except to ignite the fuel. Most magneto systems are very economical to operate due to their durability and low maintenance cost.

The two most commonly used magnetos are the flywheel and the external types. Flywheel magnetos are found on many small engines. The magnets are imbedded in the flywheel and are not visible from outside the engine. The magnet is made of a special alloy called "alnico".

Poles of the armature are separated from the magneto by a small air gap. The magnetic field is located in the soft iron armature. The lines of force move through the armature coil as the magnet moves past the pole pieces.

The coil is made up of a primary winding (few turns of large wire) and secondary winding (many turns of fine wire).

Two ends of the primary coil are connected to the breaker points; the other two ends are grounded to the frame of the engine. Current flows through the primary coil as the moving magnets in the flywheel reach the poles with the breaker

points closed. When the breaker points open, the magnetic field collapses and the lines of force cut through the primary coil for the second time, sending about 100 volts through the coil. The collapsing magnetic field cuts through the secondary coil increasing the current to several thousand volts. A condenser is connected to the primary circuit between the breaker points to prevent excessive arcing between the points and cause the magnetic field to collapse quickly. The most important function of the condenser is to cause a quick collapse of the magnetic field.

Some engines have provision for adjusting the timing whereas others are non-adjustable. Engines that are to be timed have manuals that accompany them giving the degrees or fractions of an inch of piston travel before reaching dead center. The actual timing of the spark is done by having the breaker points open at the proper time. In most engines the breaker points are opened and closed by some type of cam action.

The external magneto system operates in the same manner as the flywheel system. The main differences in the two systems are: they look different, and the external system is attached to the outside (external) part of the engine. Another type of ignition system is known as solid-state. This system is similar to the flywheel magnetic system in that the magnets are located on the flywheel. This system is different from the flywheel and external systems in current flow to the spark plug. The current passes through the coil to a diode rectifier where it changes from an alternating to a direct current. This direct current passes through a capacitor (works similar to a condenser) after remaining stored until the flywheel makes one half turn, then it flows directly to the spark plug.

Transparency No. 10

Cooling - Most small engines are air-cooled. In order to facilitate cooling, the cylinder and cylinder heads are made with fins or ridges. These fins and ridges make it possible to have thinner walls for the cylinder and cylinder heads and at the same time increase the area exposed to the circulating air around the engine. The fins on the flywheel serve as a fan to blow air into the hot parts of the engine. Blower shrouds and baffles are used to direct the air flow.

Transparency No. 10

Lubrication - Four-cycle engines are lubricated by a supply of oil contained in the crankcase. The systems of supplying oil over the crankcase area and to the cylinder walls are as follows:

Dipper System - Oil is picked up by a dipper that is attached to the connecting rod. The oil is splashed over the crankcase area.

Oil Slinger System - Oil slingers are usually attached to the cam gear. The slinger picks up oil from the reservoir (crankcase) and slings it over the crankcase area.

Oil Pumps - Some of the larger four-cycle engines are equipped with oil pumps. Pumps lift the oil from the reservoir and either spray it over the crankcase area or spray oil into a dipper.

Two-cycle engines are lubricated by a fuel-oil mixture (oil makes up a portion of the fuel). As the piston moves downward, the crankcase is pressurized, thus causing oil to condense on the bearing surface. The fuel mixture (oil and gasoline) enters the combustion chamber on the upward movement of the piston. The cylinder walls, piston and rings are lubricated by the mixture.

References:

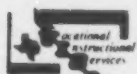
1. "General Theories of Operation", Briggs and Stratton Corporation, Milwaukee, Wisconsin.
2. "Small Engines Care-Operation-Maintenance and Repair", Volume I, American Association for Vocational Instructional Materials, Athens, Georgia.
3. "Small Engines--Principles of Operation, Trouble Shooting, and Tune-Up", University of Illinois, Urbana, Illinois.
4. "Small Engines Service Manual", Intertec Publishing Corporation, Overland Park, Kansas.
5. "The Two-Cycle Engine", University of Illinois, Urbana, Illinois.

WHY SMALL ENGINES ARE ADAPTABLE TO MANY KINDS OF JOBS

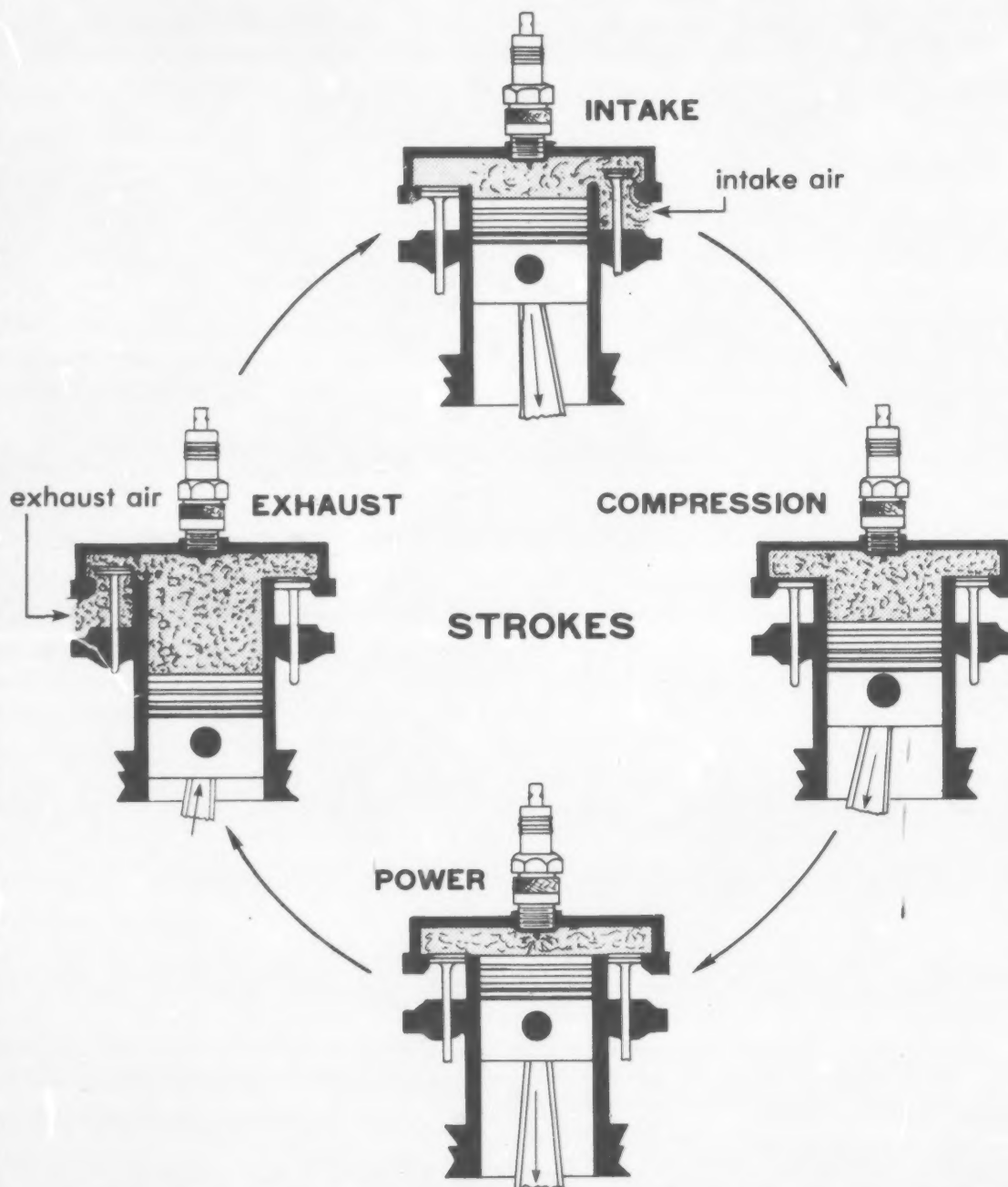
- ◆ LIGHTWEIGHT
- ◆ PORTABLE
- ◆ ECONOMICAL FUEL USE
- ◆ AIR-COOLED
- ◆ COMPACT
- ◆ EASY TO SERVICE
- ◆ SOURCE OF POWER FOR SMALL EQUIPMENT

EQUIPMENT POWERED BY SMALL ENGINES

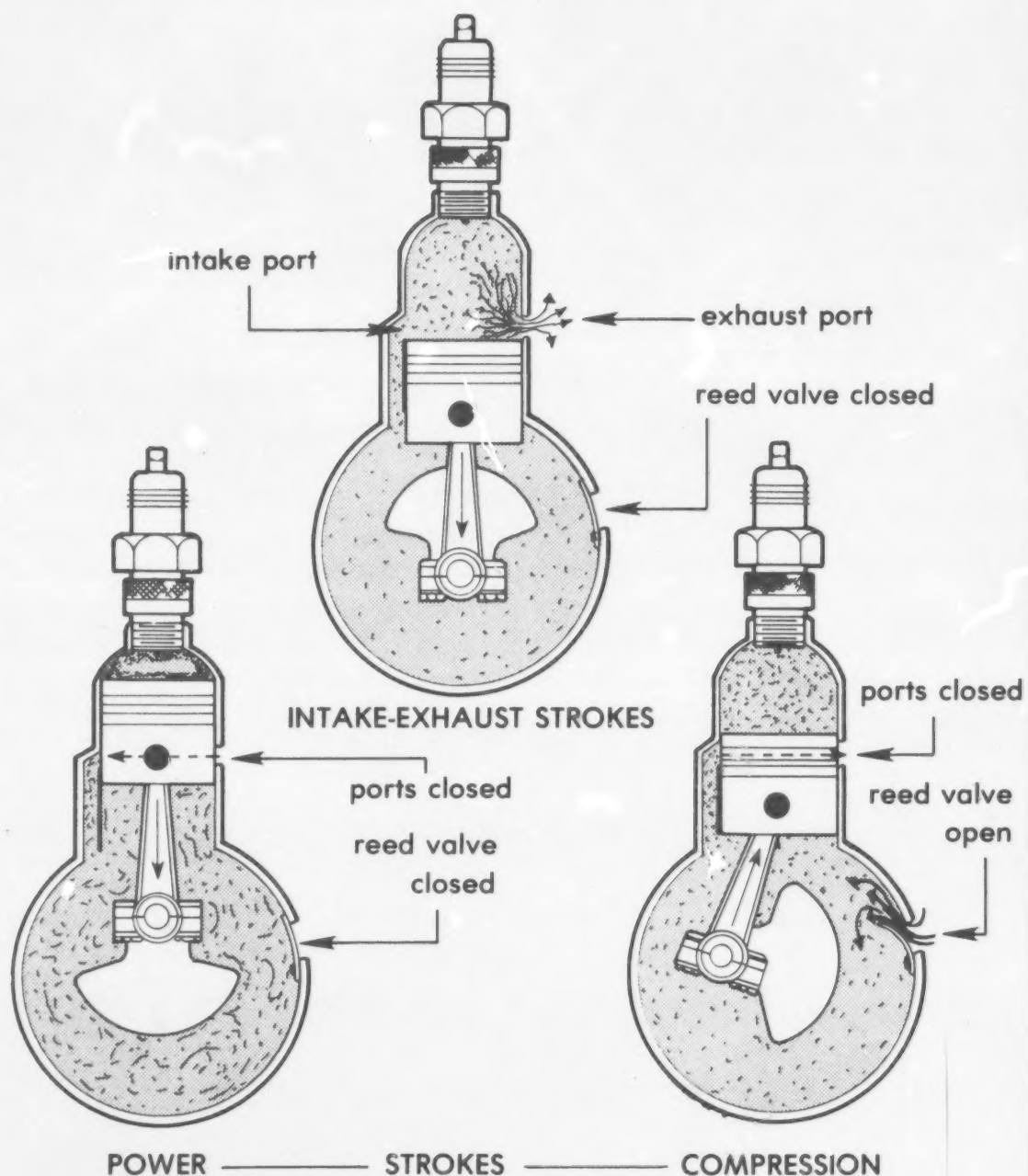
- ◆ MOWERS
- ◆ BRUSH CUTTERS
- ◆ CHAIN SAWS
- ◆ ROTARY TILLERS
- ◆ CONVEYORS
- ◆ IRRIGATION PUMPS
- ◆ ELEVATORS
- ◆ SPRAYERS
- ◆ POST HOLE DIGGERS
- ◆ CONCRETE VIBRATORS
- ◆ SMALL FEED GRINDERS
- ◆ GENERATORS
- ◆ CONCRETE SURFACERS
- ◆ OUTBOARD BOATS
- ◆ AIR COMPRESSORS
- ◆ SMALL TRACTORS



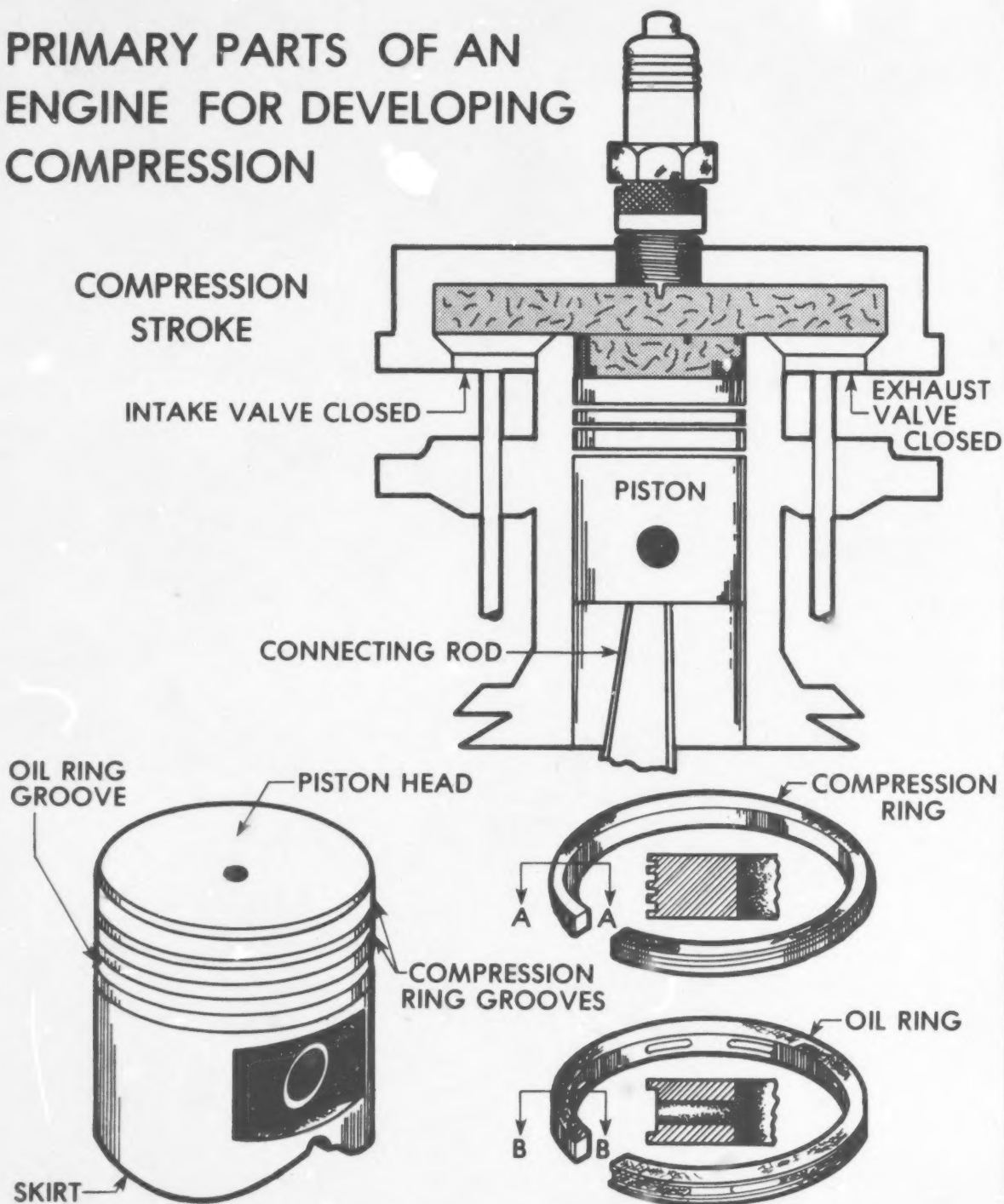
OPERATION OF A FOUR-CYCLE ENGINE



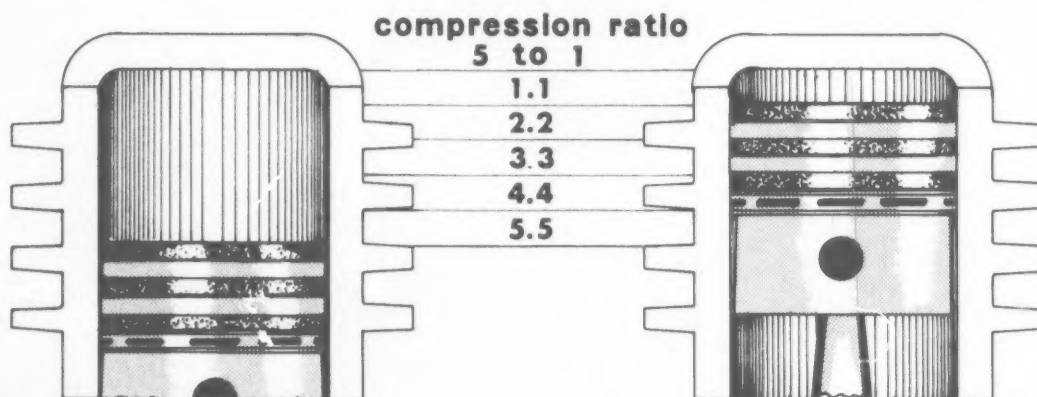
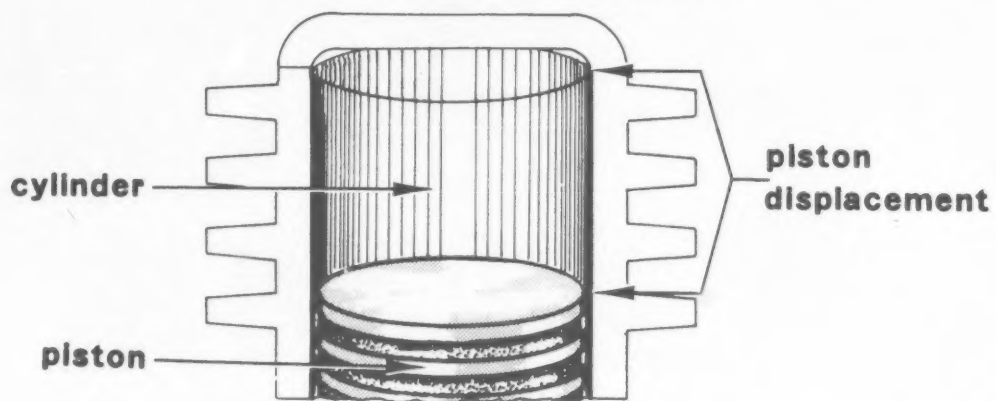
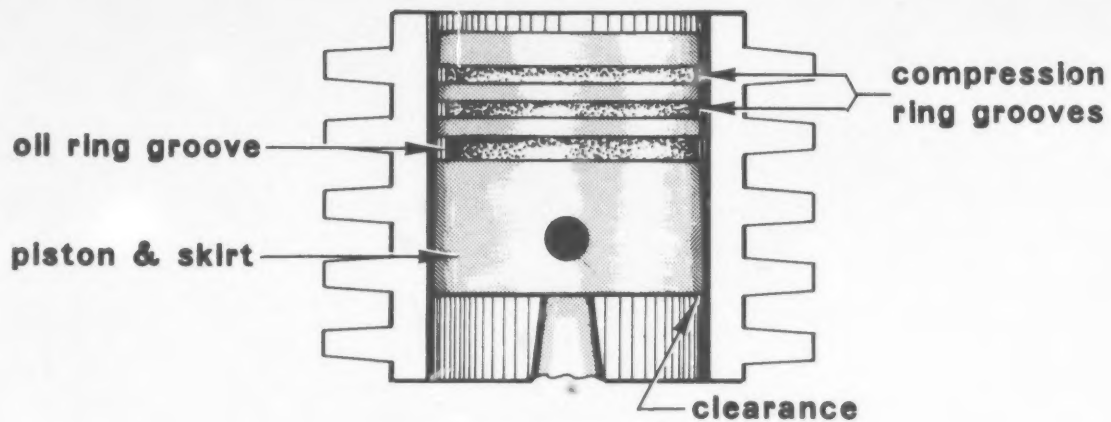
OPERATION OF A TWO-CYCLE ENGINE



PRIMARY PARTS OF AN ENGINE FOR DEVELOPING COMPRESSION

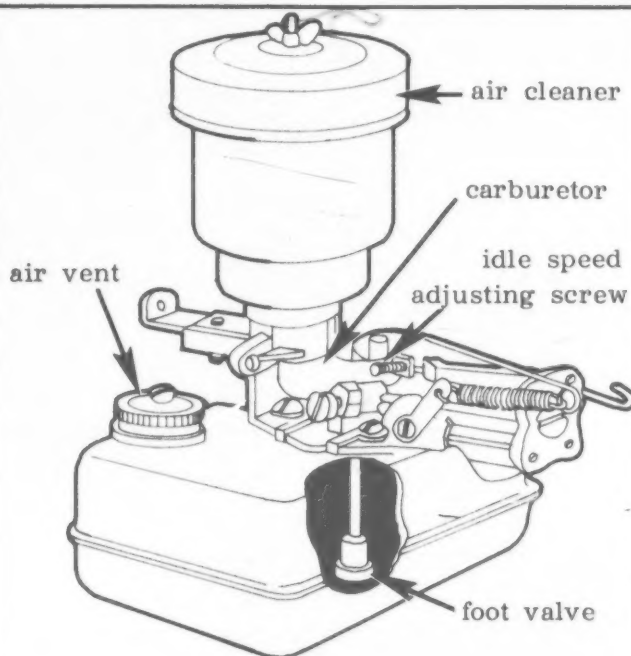
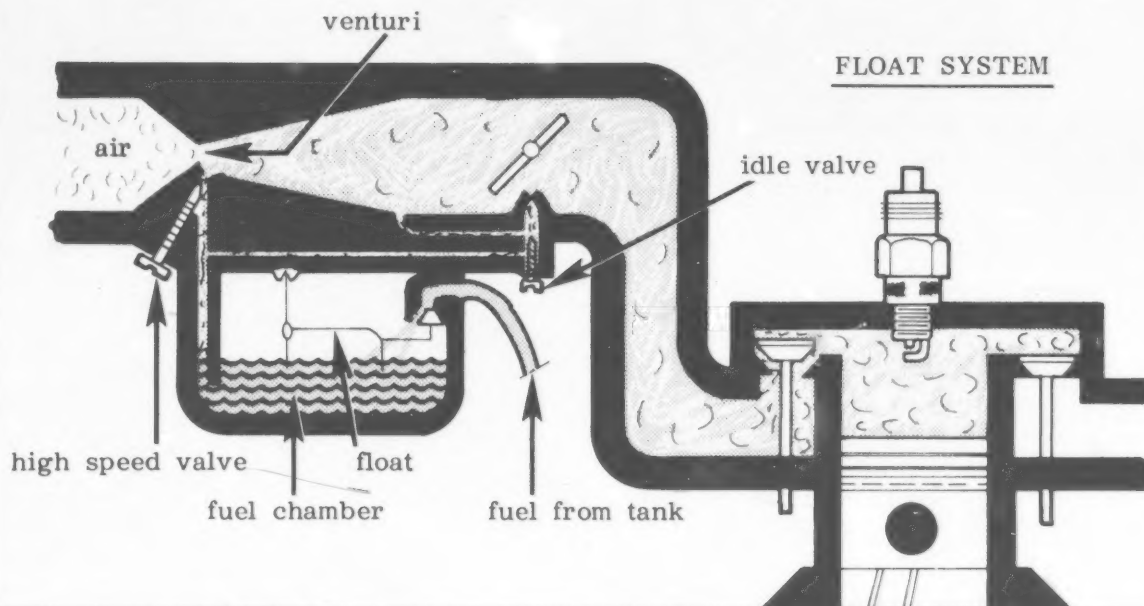


PISTON CLEARANCE, DISPLACEMENT, AND RATIO

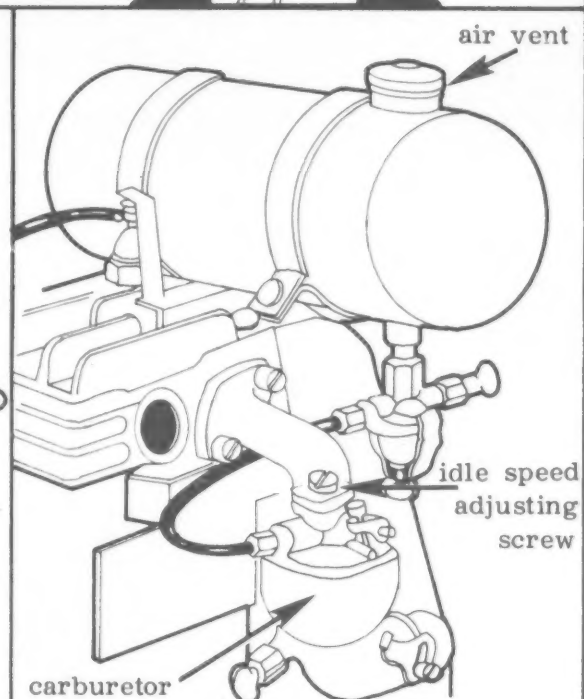


TYPES OF CARBURETORS

FLOAT SYSTEM



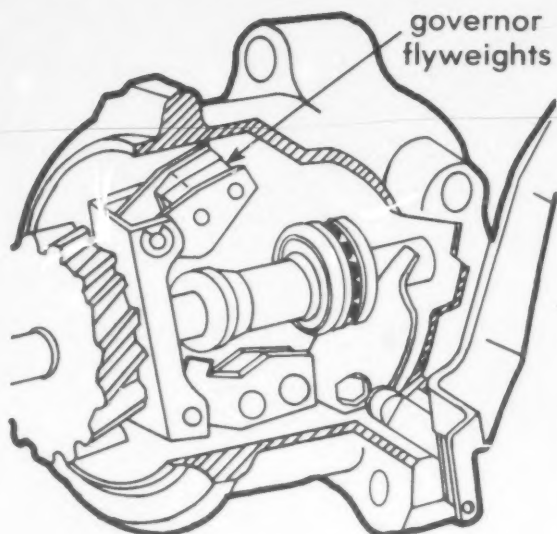
SUCTION SYSTEM
(Vacu-jet Carburetor)



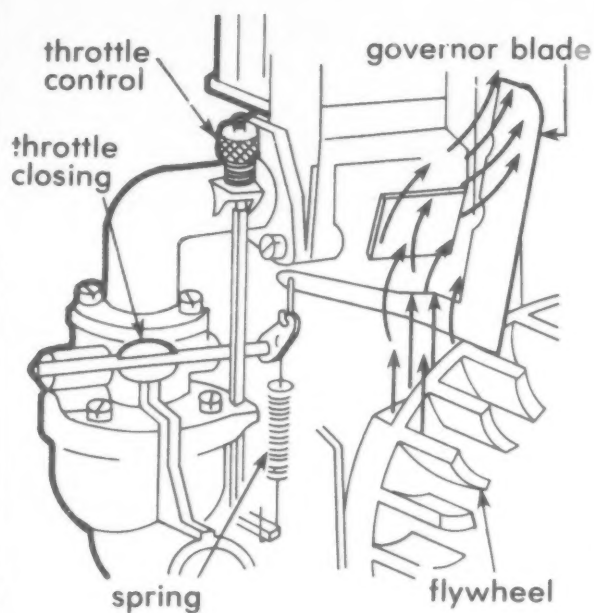
GRAVITY SYSTEM
(Flow-jet Carburetor)



TYPES OF GOVERNORS

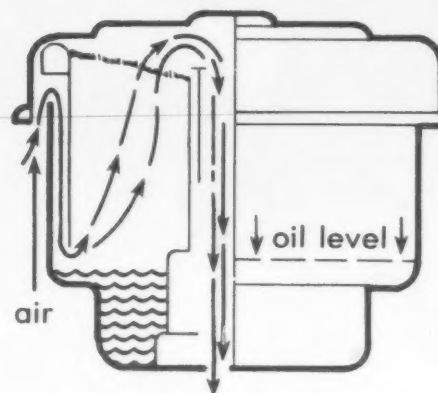


CENTRIFUGAL GOVERNOR



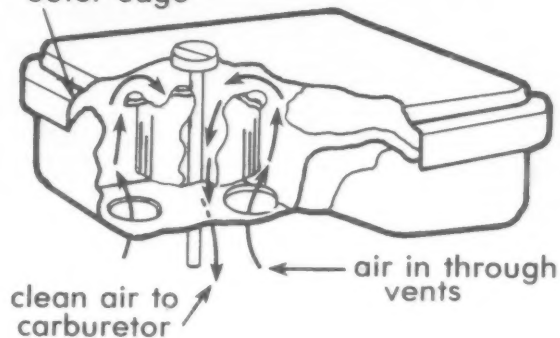
AIR-VANE GOVERNOR

TYPES OF AIR CLEANERS

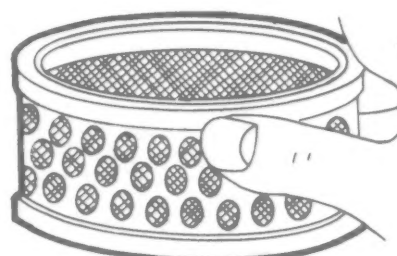


OIL BATH AIR CLEANER

air seal around
outer edge



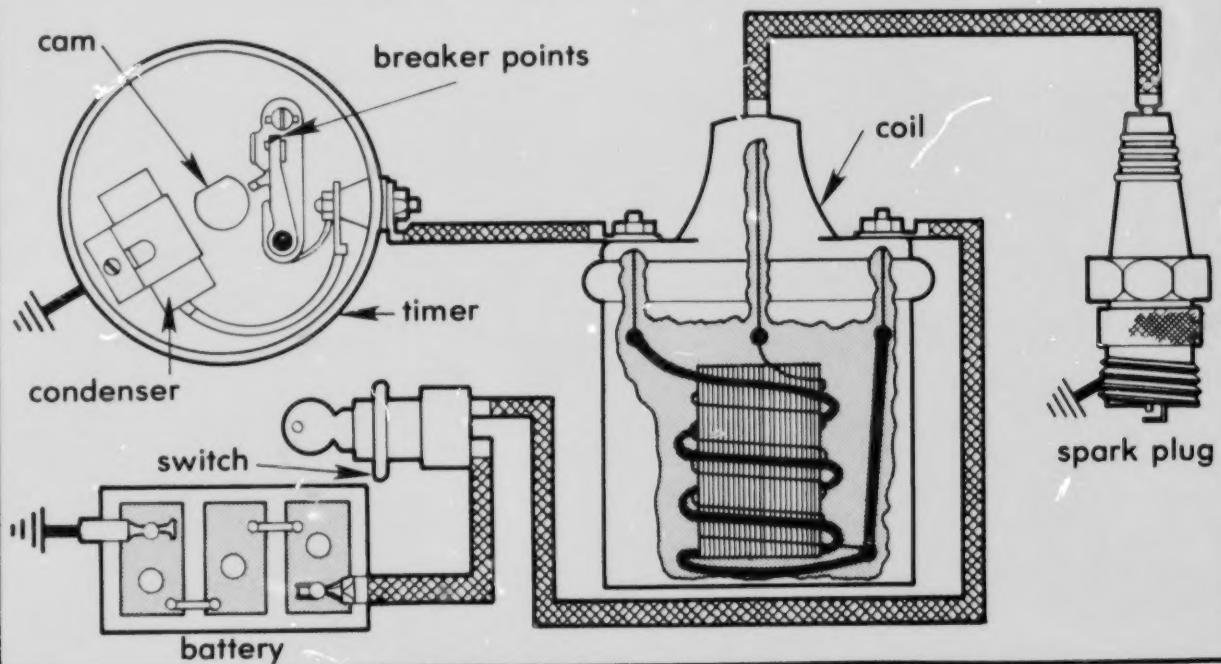
OIL SATURATED AIR CLEANER



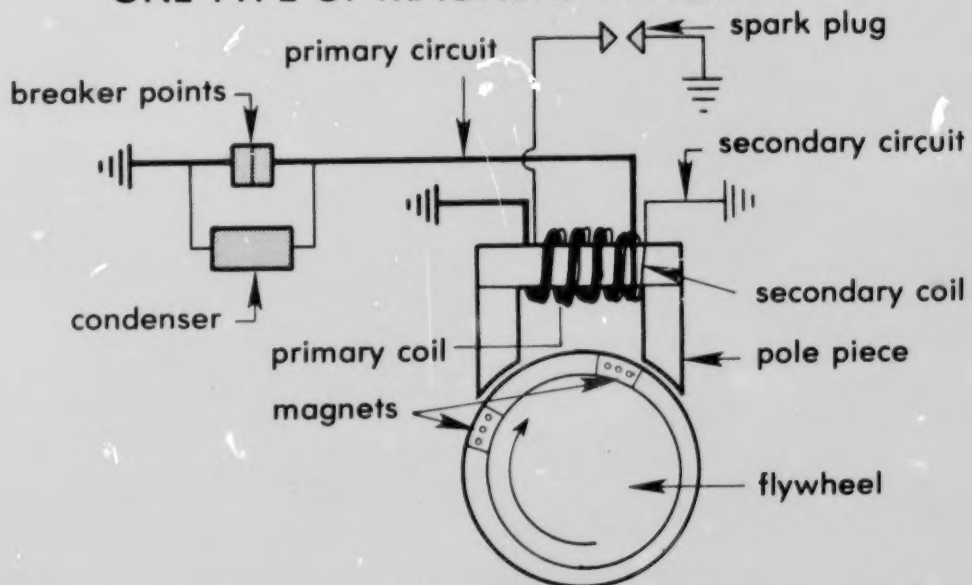
DRY TYPE

IGNITION SYSTEM

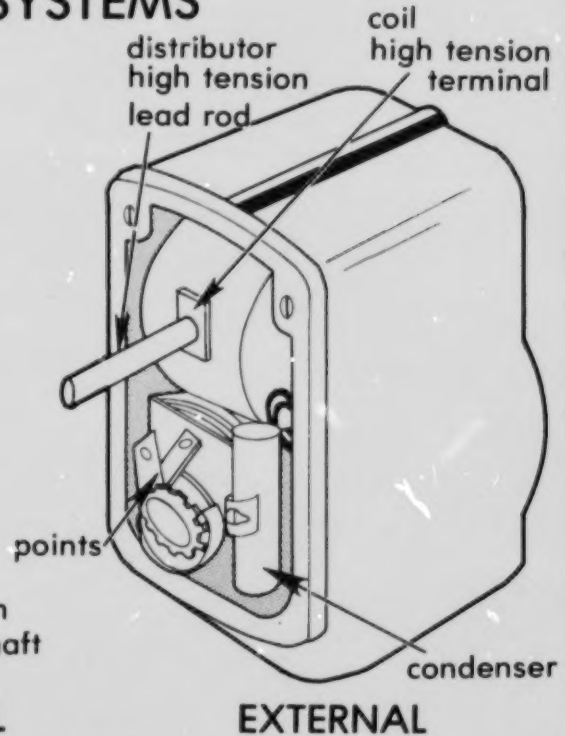
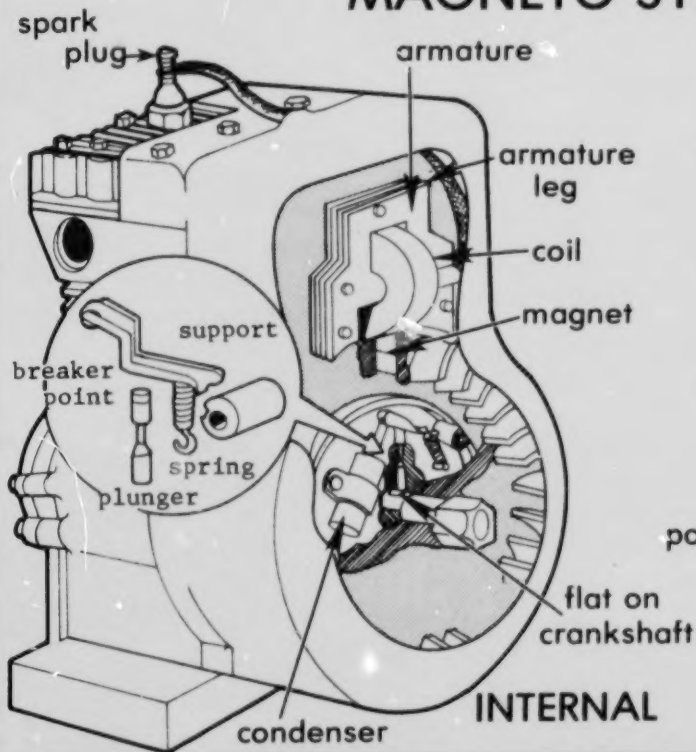
ONE TYPE OF BATTERY SYSTEM



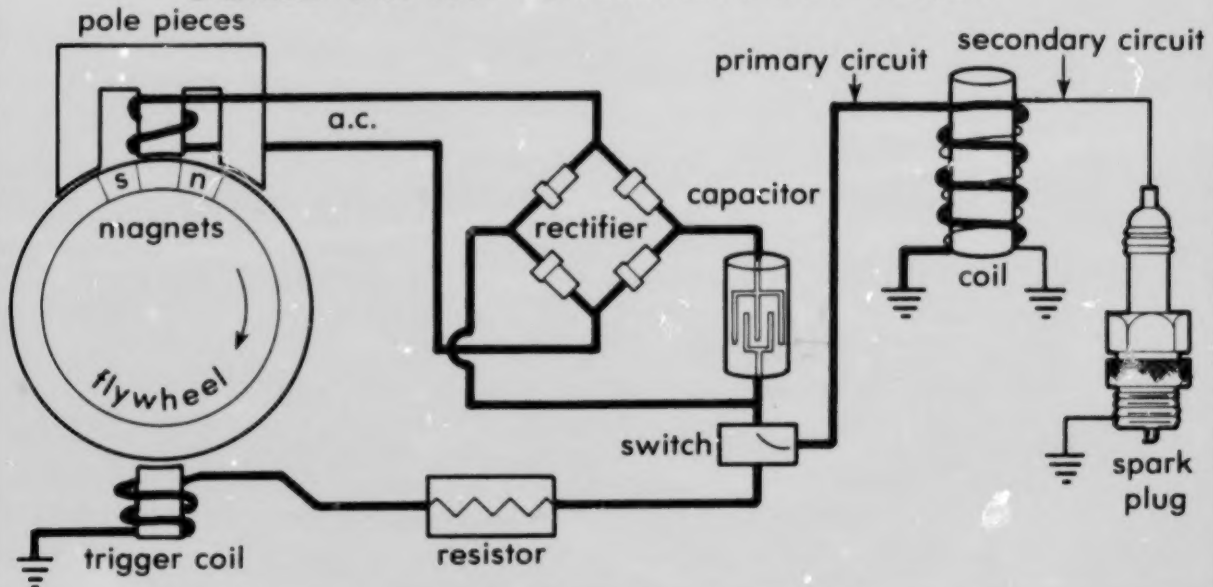
ONE TYPE OF MAGNETO SYSTEM



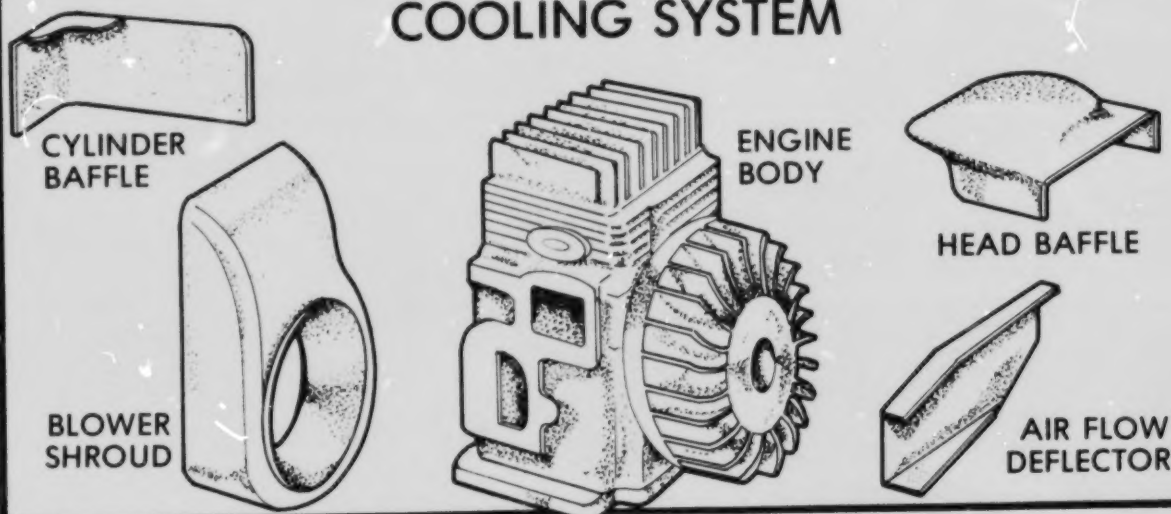
MAGNETO SYSTEMS



SOLID-STATE IGNITION SYSTEMS

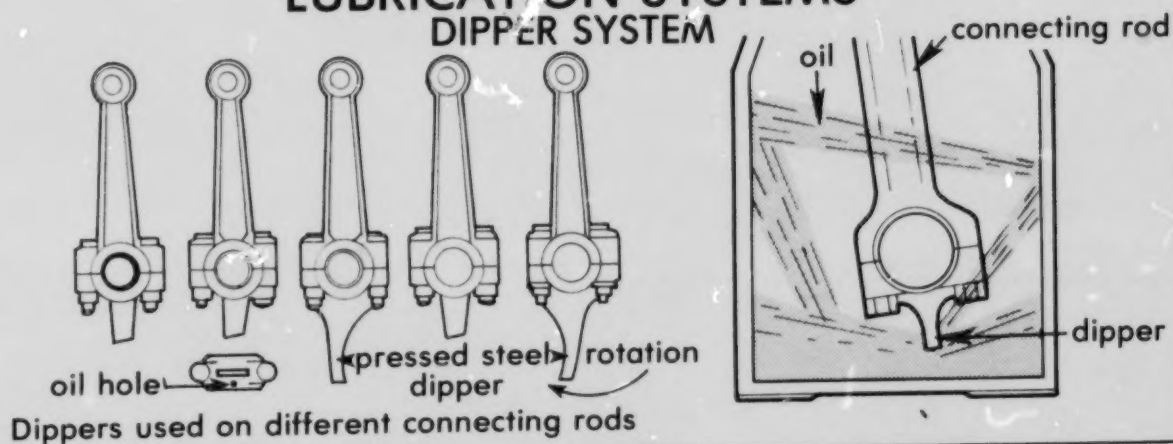


COOLING SYSTEM

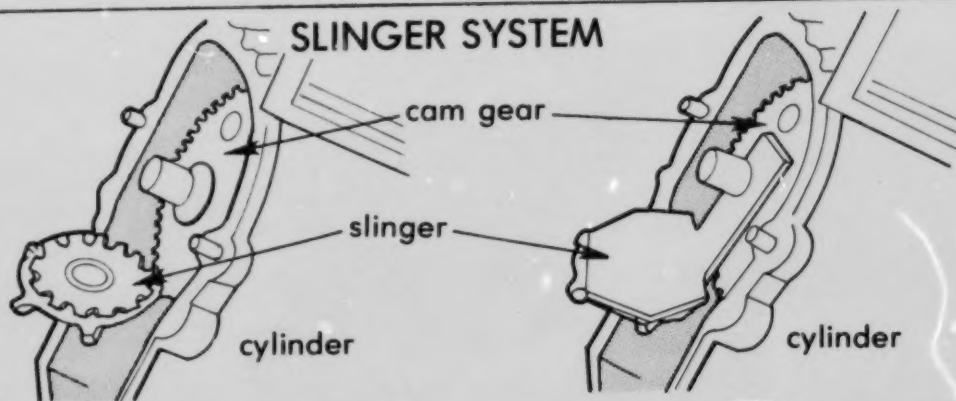


LUBRICATION SYSTEMS

DIPPER SYSTEM



SLINGER SYSTEM



AGRICULTURAL MECHANICS

UNIT B: Agricultural Power - Small Gas Engines

TOPIC 2: Disassembly and Reassembly of the Small Air-Cooled Engine

Suggested Procedures and Activities: The use of transparencies, slides with script and a disassembled engine may be helpful in explaining the topic.

1. Introduction

Preventive maintenance for small engines is similar to that for larger engines. Maintenance practices such as periodic oil level checks, spark plug inspection, keeping the engine clean and changing oil as recommended by the service manual are necessary for long engine life. Normal wear will eventually cause many moving parts to be replaced or normal wear will cause a complete overhaul. Small engines may be reconditioned at a reasonable cost if proper tools are available. In some cases it may be more economical to buy a new engine than to pay for a complete overhaul.

If a small engine is to have a useful and prolonged life, it is very important that the recommendation be followed in the operator's manual.

2. Cleaning the Engine

The engine should be thoroughly cleaned before it is disassembled. The steps in cleaning are:

- a. Dry dirt should be loosened with a stiff brush and putty knife.
- b. Blow loose dirt and other foreign material off the engine with an air hose, but avoid getting dirt into internal parts of the engine.
- c. Oil and grease should be removed by using a solvent and rags. It is unsafe to use gasoline as a solvent. Remove air deflectors, cylinder baffles and blower shroud in order to make the cleaning easier.

3. Preliminary Steps Used in Disassembling an Engine

Transparency Nos. 1a and 1b

- a. Remove the air cleaner assembly (stud, wing nut and air clamp). Old oil should be drained from the oil bath type and discarded. Any type of air cleaner (oil bath or dry) should be set aside for servicing.

- b. Drain the crankcase by removing the drain plug. Oil will flow more freely if it is warm. The pump can be cleaned after removing it from the engine. Dispose of used oil.
- c. Drain the fuel from the tank and carburetor. The fuel should be stored for use in the engine at a later date.
- d. If an operator's manual is not available or fails to show throttle linkage and carburetor connections, sketches should be drawn before disassembling these engine parts. Governor and throttle connections must be reconnected properly.
- e. Disconnect the governor link. Governor spring should be removed without excessive stretching so the link will not be distorted.
- f. Disconnect the fuel supply lines. If the engine has a gravity flow-type system, remove the fuel tank and then disconnect the carburetor from the tank and then disconnect the carburetor from the engine. If the engine has a suction system, remove the tank and carburetor together.
- g. Remove the muffler if it is to be replaced, otherwise it is usually advisable to leave it attached to the engine. Use penetrating oil on muffler threads.

4. Disassembly of An Engine Carburetor

Transparency No. 2

There are many types of small engine carburetors. Generally the float-types are similar in design and the suction-types are similar. The suction-type has a built-in fuel pump. The two types of the float-type carburetor are one-piece and two-piece.

a. Float-Type Carburetor

Remove the main fuel jet if it is diagonally installed on the side of the carburetor. This jet should be removed before separating the two halves of the carburetor. Use a proper size screwdriver on the main fuel jet (nozzle).

Remove the needle valve by loosening the valve and nut together.

Remove the bolts that hold the two sections of the carburetor together. Mark the gasket (s) so that a new one may be replaced properly.

Pull the pin from the float hinge and remove the float valve. Remove the idle mixture valve.

If the engine is supplied with a diaphragm-type carburetor, it should be disassembled in a similar manner as the float-type carburetor. The fuel pump is usually built in this type of carburetor. In disassembling the diaphragm-type carburetor, the diaphragm is removed from the main body of the carburetor.

It may be necessary to remove the choke valve and butterfly from the carburetor.

b. Suction-Type Carburetor

Remove the carburetor from the fuel tank. The broad and shallow tank corresponds to the carburetor bowl.

Place the fuel pipe in a vise and pry it out of the carburetor body.

If the suction-lift carburetor has adjusting needles, they should be removed.

- c. After the carburetor has been disassembled, all parts should be cleaned with a gum solvent or lacquer thinner. Parts made from synthetics such as nylon should not be soaked for more than 30 minutes. Other parts may remain in a solvent (Bendix, petisol or thinner) for several hours. The engine may be disassembled during the time the carburetor is soaking.

After all parts of the carburetor have been cleaned and checked for wear, reassemble in reverse order of disassembly.

- d. An examination may be made of each part of the carburetor during disassembly or before reassembly. The parts that should be examined are:
- (1) Needle Valve (S) - If the valve has a worn ring or rim, it should be replaced by a new one with new seats.
 - (2) Float - The float should be checked for leakage or damage.
 - (3) Throttle Shaft - The bushing should be replaced if the wear is more than .010 inches.
 - (4) Fuel Jet - The fuel jets should be cleaned, and if it appears to be damaged, it should be replaced.
 - (5) Gaskets - All new gaskets should be used when reassembling the carburetor.

Transparency No. 3

5. Disassembly of the Engine Starter

Remove the blower (flywheel) housing from the main body of the engine. The method of removal will depend on the type and brand of the engine.

Remove the starter. On certain makes of engines, the engine cowl or a part of the equipment is removed with the starter.

If the starter is to be disassembled, it should be placed in a vise or secured by a C-clamp before working on it. The rope can be removed by pulling it all the way out and locking the starter in place with vise-grip pliers. If the spring is removed, the starter may be rewound by a screwdriver or special rewinding tools. The two most popular types of small engine starters are the

rope-wind and the wind-up. Both types have a recoil spring. Some small engines are equipped with a regular starter motor.

6. Disassembly of the Main Body of the Engine and Its Parts

Transparency Nos. 3 and 4

- a. After the shroud and deflectors have been removed and before removing the flywheel nut, the threaded end of the flywheel shaft should be checked to determine whether it has a right or left hand thread.

The flywheel may be removed by using a special holder or wood blocks and a socket wrench. If screwdrivers or wrecking bars are used as a holder, it is possible that the fins will be damaged, throwing the flywheel out of balance. The socket wrench handle should be tapped with a mallet to loosen the nut.

If the shaft is tapered and the flywheel is secured by a key, it may be removed by holding the engine a couple of inches from the table and tapping the shaft sharp blows with a lead hammer or hit a hardwood block placed on the shaft. An impact nut on the end of the shaft will protect the threads.

Flywheels mounted on a standard crankshaft may be removed by the use of a special wheel puller.

- b. Remove the spark plug by using a spark plug wrench. A spark plug wrench is cushioned to protect the porcelain part of the plug.
- c. Remove the cylinder head bolts and gasket. Mark the bolts and holes to facilitate reassembly. Some of the bolts are of different lengths and serve purposes other than holding the cylinder head in place.

Remove the carbon from the head, the top of the piston and from around the valves.

Transparencies No. 5 and 6

- d. The crankcase is opened on four-cycle engines by removing the oil sump or a PTD plate. Remove the rod-bearing access plate or the carburetor and reed plate on 2-cycle engines. Engines with ball bearings supporting the crankshaft have grease seals and locking nuts that must be removed before the side can be taken off. Engines with sleeves around the crankshaft may not be sealed in the same manner.

Use a sharp tool to pry out the seal. Remove the locking nuts and then the bearing. Before removing the side or oil sump of an engine to expose the crankcase, rough places may be corrected on the exposed area of the shaft.

Open the crankcase without disassembling the cam gear. Most cam gears have timing marks. If the marks are not visible, make them by using a center punch before unmeshing the gears. Some engines have alignment dowels that must be removed before opening the engine.

- e. Turn the piston in the bottom dead center position and examine the upper end of the cylinder for a sharp ridge. If a ridge is present, remove it with a ridge reamer before removing the piston.

Check the bearing and connecting rod for marks. Mark these parts before removing the crankpin bearing cap. Remove the capscrews from the bearing cap. Push the piston-and-rod out the top if the engine has a removable head. Many two cycle engines do not have a removable head; therefore, the piston-and-rod must be removed from the bottom. In order to keep all parts in place, replace the bearing cap. Remove the crankshaft.

- f. If the cylinder does not require reboring, disassemble the piston-and-rod assembly in the following order:
 - (1) Remove the piston retainer rings that are located on the piston pin.
 - (2) Use a piston ring expander to remove the rings. A small screwdriver or long-nose pliers may be used to remove the rings.
 - (3) Place the rings in order and the proper side up so they may be replaced in the proper grooves.

Transparency No. 7

- g. Valves are easier to remove if a valve-spring compressor is used to press the springs before trying to remove the valve retainer. The valve should be held closed with the hand if it is removed by using a screwdriver. Remove the retainer lock with pliers or a screwdriver depending upon the type of retainer lock.

Remove the valves and mark them exhaust or intake. If the springs and caps are removed they should be marked so they may be placed in the proper valve hole.

If burrs are found on the valve stem, they should be removed with a file before forcing the valve through the opening.

Two-cycle engines have a reed valve or the piston serves as a sliding valve. The reed valve is usually not removed unless it is necessary to replace it.

- h. Remove the camshaft by removing the gear cover or base plate, that is, if the engine has a vertical crankshaft or does not have an oil sump. Mark the crankshaft and the cam gear.

The crankshaft should be turned so that the timing marks are aligned on the compression stroke. Both valves should be closed. Pressure from the tappets is relieved by this action. The tappets will remain in place while removing the camshaft if the crankcase is turned on its side or placed upside down. Mark the valve tappets and remove them one at a time. The tappets should be reinserted in the same holes from which they came.

Transparency No. 8

1. In order to restore the engine to the proper operating condition, measurements must be made for minimum, maximum and rejection dimensions. The measurements should be compared with the operator's manual. An examination should be made of the following internal engine parts:
 - (1) Cylinders - The cylinder should be checked for oversize in diameter, out-of-round and taper.
 - (2) Piston - Check the piston for carbon deposit in ring grooves. Check also for excessive piston skirt clearance and wear on the top ring. Check the rings for wear. Check piston pin for roundness.
 - (3) Crankpin - Check the crankpin for diameter wear, out-of-round and scoring. Replace the rod if the pin is worn.
 - (4) Crankshaft - Usually no adjustment is necessary on the crankshaft. Check for wear, out-of-round, damaged gear teeth, flat plunger, damaged key slot, taper, and the bearing condition.
 - (5) Cam Gear Assembly - Measure the eccentric on the camshaft. Check the spark advance if one is installed. Check the tappets for wear. If the oil passes through the shaft, check the passageways. Check the magnetic side cam gear bearing.
 - (6) Piston Rods and Bearings - Check the rod for cracks and straightness. Check rod-bearings cap with a piece of plastigage across the full width of the cap.
 - (7) Valves and Valve Accessories - These parts should be checked for the following conditions:
 - Warped head
 - Burned, cracked or out-of-round face
 - Bent or worn stems
 - Gum and varnish deposits
 - Unsquare springs
 - Cracked and pitted seats
 - Worn and corroded bushings

7. Reassembling the Engine Parts

Transparencies Nos. 9 and 10

- a. Replace the bearing on the crankshaft by heating it in oil and slipping the bearing on the crankshaft while it is still hot. As the metal cools, the bearing will tighten on the shaft.
- b. In many four-cycle engines that are made of aluminum alloy, the tappets are oiled and installed in the order they were removed. After the tappets are replaced, the crankshaft and the cam gear are installed. The timing marks on the crankshaft and cam gears must be aligned. In cast iron engines the tappets are attached to the cylinder and then the cam gear is installed.

- c. Clean the cylinder walls with an oil soaked rag. Check the ring gap and install rings in the correct position on the piston. Use a ring compressor to install the rings.

Install the oil ring and then compression rings. The center ring may have a scraper groove; therefore, it must be installed with the scraper groove down. If the top rings have a recess, the recess goes up. Attach the connecting rod to the piston. The piston and rod may be marked to identify rod and piston alignment. Some two-cycle engines have pistons with a small pin or knob to prevent the ring from turning. They must be installed properly.

Check the ring gap and groove with a feeler gauge. Insert the piston in the cylinder so that the connecting rod is in contact with the block. Use a ring compressor to squeeze the rings into the grooves. Push the piston into the cylinder.

Oil all parts and put on the bearing cap. Tighten the bearing bolts with a torque, using about 90 inch-pounds. If the engine turns freely, the bolts should be locked. If an engine does not turn freely, the piston should be checked to determine whether or not they were installed backwards.

- d. After the valves have been refaced and seated properly they should be replaced in the engine. The valve springs and keepers should be replaced by using the spring compressor and pin inserter. Needle nose pliers can be used to insert the pin. Turn the engine several times to be sure the valves are opening and closing properly.
- e. The engine head should be replaced after the valves are installed and seated. Use a new head gasket between the head and cylinder. The head bolts should be drawn up evenly with a socket wrench and the final tightening should be done with a torque wrench. The bolts should be tightened evenly, alternating the tightened bolts from one side to the other.

Transparency Nos. 11a and 11b

8. The Engine Ignition System

An ignition system that functions properly will produce a spark that jumps a gap larger than is recommended for the spark plug setting. Ignition systems may be classified according to their location on the engine. These classifications are:

Coil and armature outside the flywheel (breaker points located on the side of the engine).

Coil and armature inside the flywheel (breaker points located under the flywheel).

Usually the parts that are removed and replaced are the breaker points, condenser and spark plug. If the breaker points or condenser are to be removed, it is necessary to remove the dust cover on either of the two

types of ignition systems. The flywheel must be removed if the inside-type ignition system is to be checked. After the parts have been replaced and the points set, the flywheel is replaced and covered by a dust cover. It is not necessary to remove the flywheel to check the external-type of system.

9. Replacing Other Major Parts of the Engine

The following parts may be reassembled on the engine in the following order:

- a. Install spark plugs
- b. Starter pulley or clutch
- c. Governor blade
- d. Breather assembly
- e. Muffler and fuel tank
- f. Carburetor and linkage (align pneumatic governor)
- g. Blower housing
- h. Install fuel line

10. Operating Steps

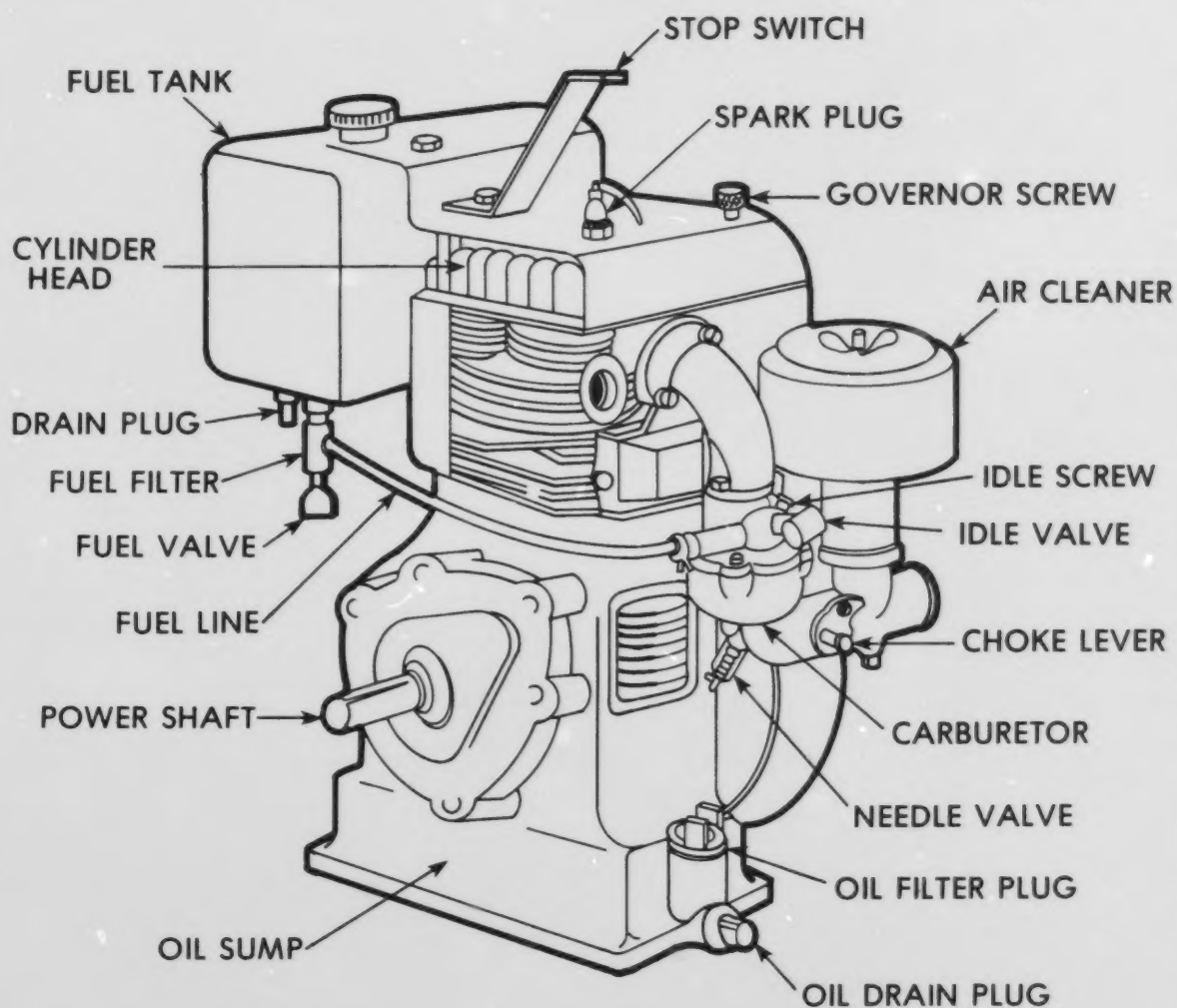
- a. Refill crankcase (4-cycle engine) with the proper oil.
- b. Refill the oil bath air clean (if this is on the engine) with clean oil.
- c. Use a proper mixture (2-cycle engine) to fill the tank.
- d. Adjust main jet valve on carburetor so engine will run smoothly.
- e. Hold the throttle shut and adjust idle speed so engine runs smoothly.
- f. Set the idle speed by adjusting idle screw.
- g. After the engine is warm, adjust carburetor so that it will accelerate at different speeds.

The head bolts should be retightened with a torque wrench after about 10 hours of operation. It may be necessary to adjust the carburetor after the engine had been in use for ten hours.

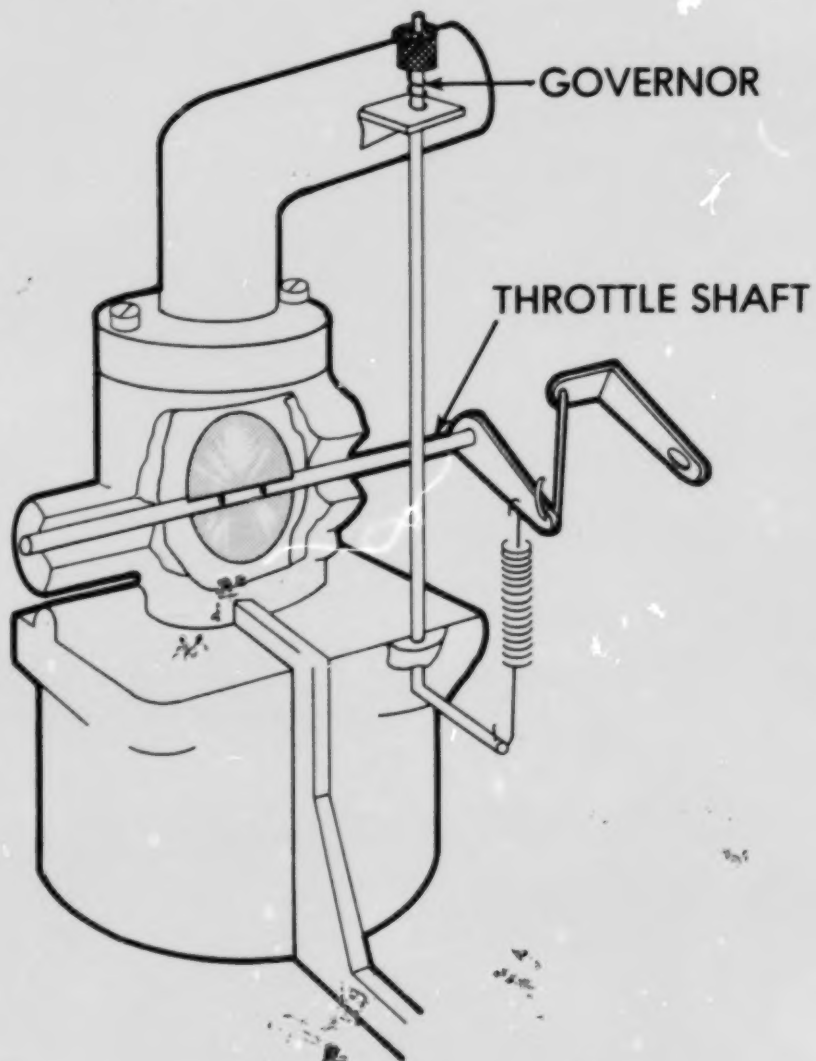
References:

1. "Small Engines Care-Operation-Maintenance and Repair", Volume II, AAVIM, Athens, GA.
2. "Small Engines-Repair and Overhaul", University of Illinois, Urbana, IL.
3. "Small Engines Service Manual", Intertec Publishing Corp., Overland Park, KS.
4. "Repair and Instructions", Briggs and Stratton Corp., Milwaukee, WI.

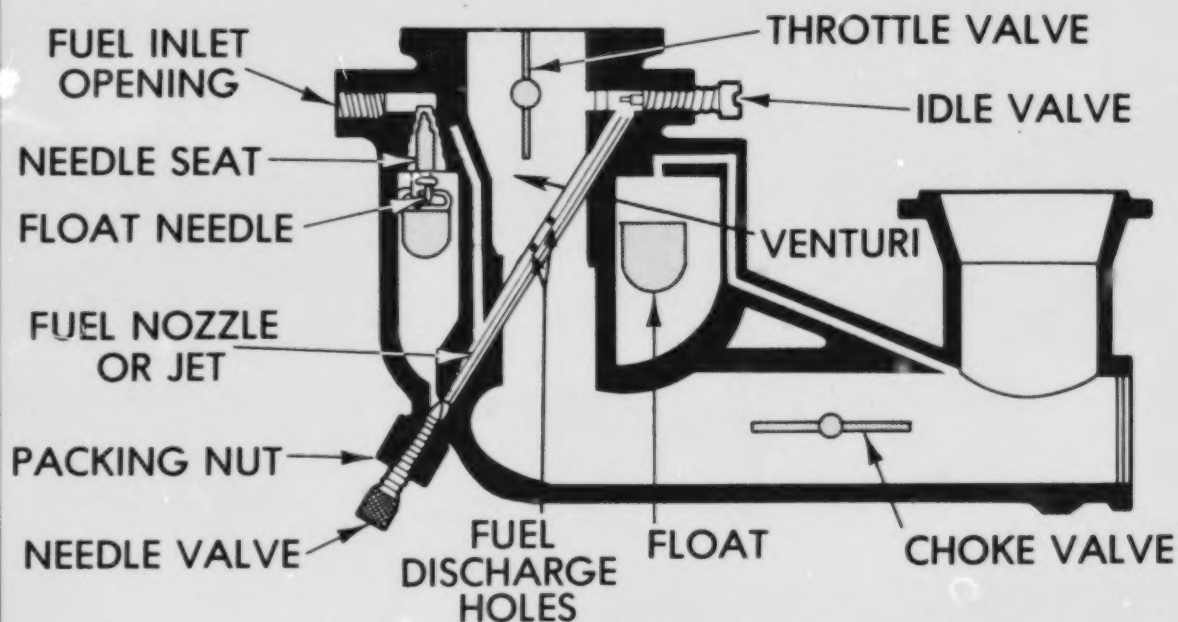
EXTERNAL PARTS OF FOUR-CYCLE ENGINE



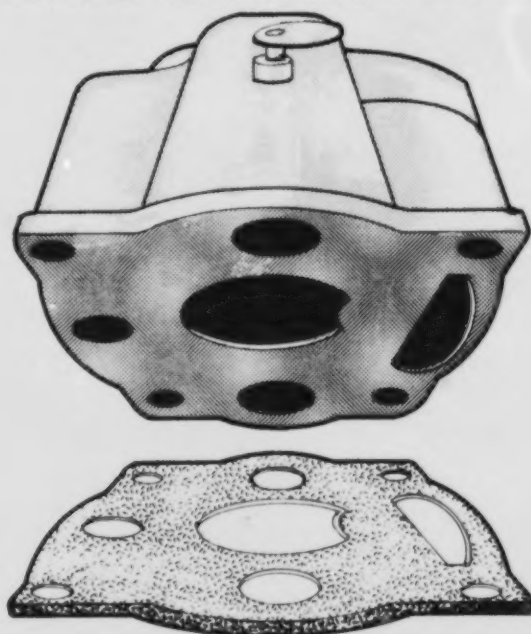
GOVERNOR AND THROTTLE LINKAGE



PARTS OF A FLOAT TYPE CARBURETOR

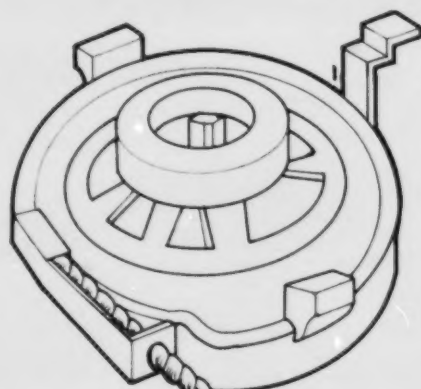


REPLACING CARBURETOR GASKET

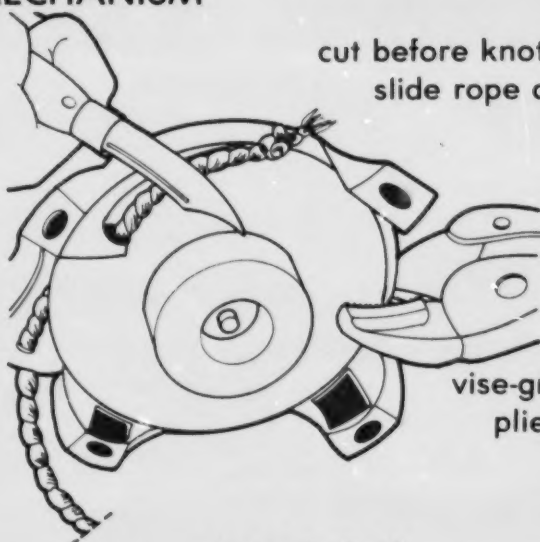


DISASSEMBLY OF ENGINE PARTS

STARTER MECHANISM



rope pulled out



cut before knot &
slide rope out

vise-grip
pliers

starter locked

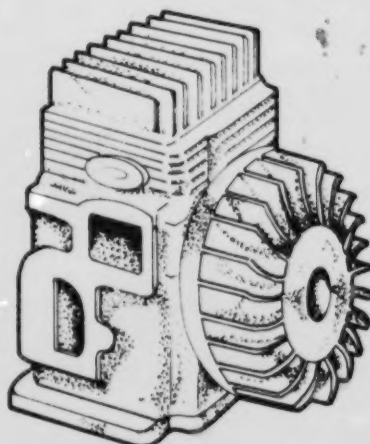
DISASSEMBLY OF DEFLECTORS



HEAD
BAFFLE



CYLINDER BAFFLE



ENGINE BODY

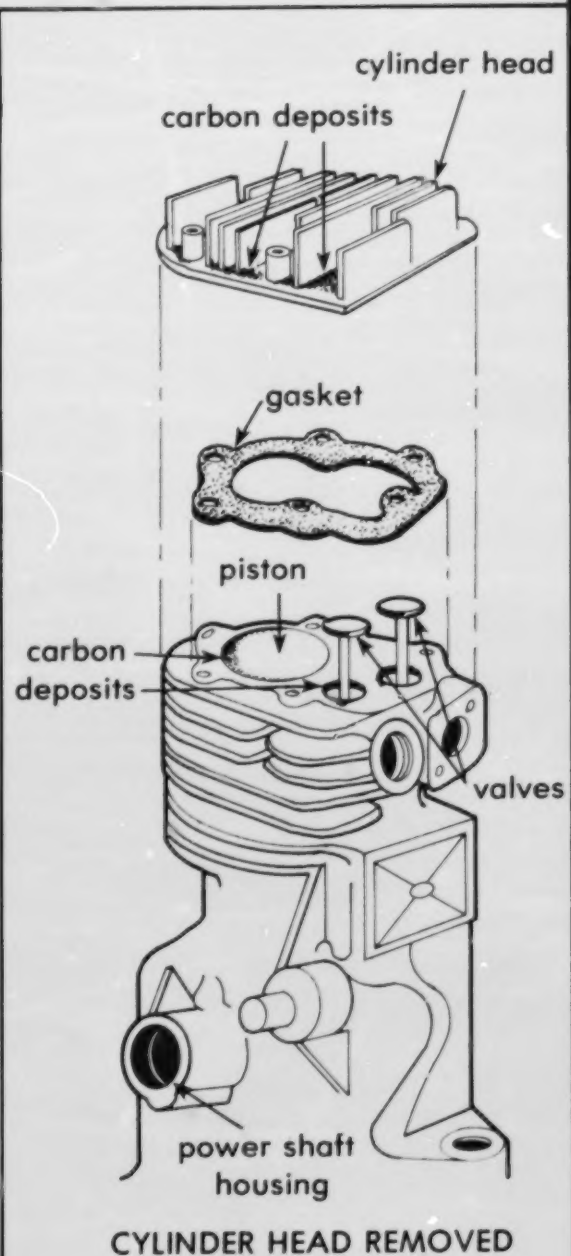
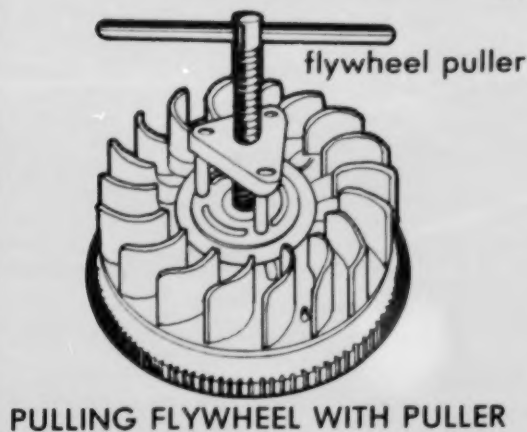
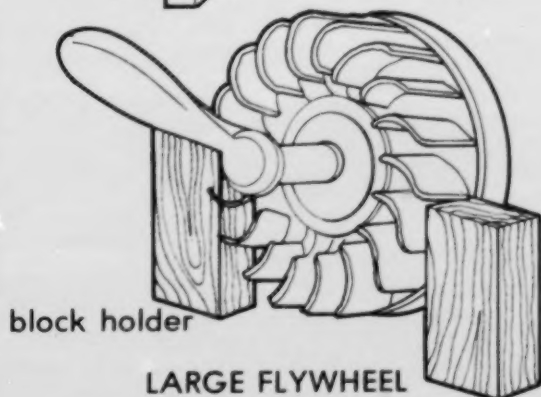
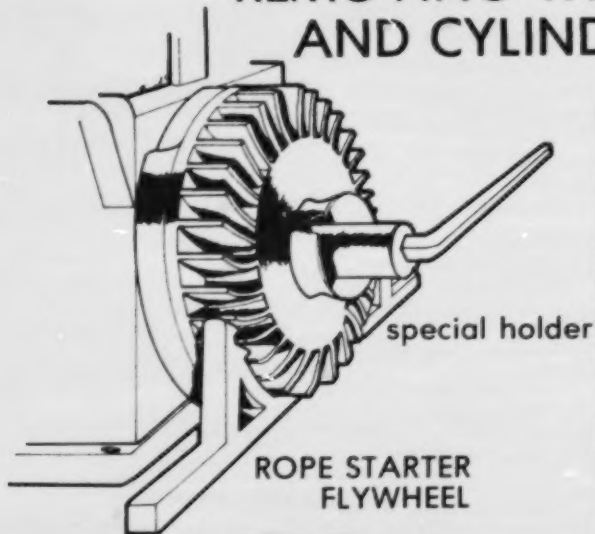


BLOWER SHROUD

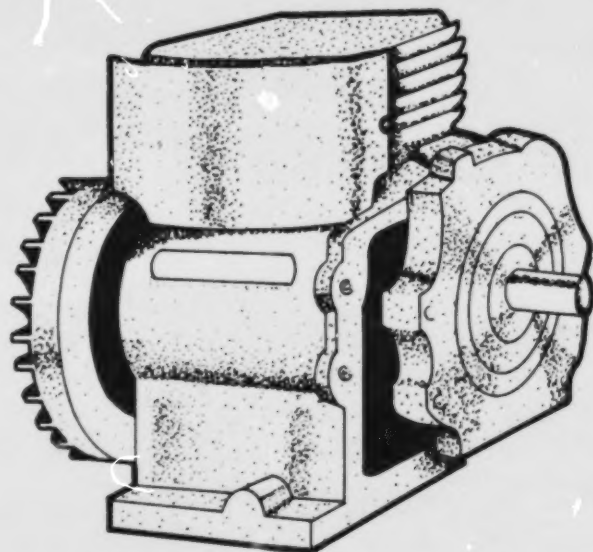


AIR FLOW
DEFLECTOR

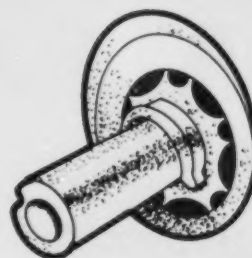
REMOVING THE FLYWHEEL AND CYLINDER HEAD



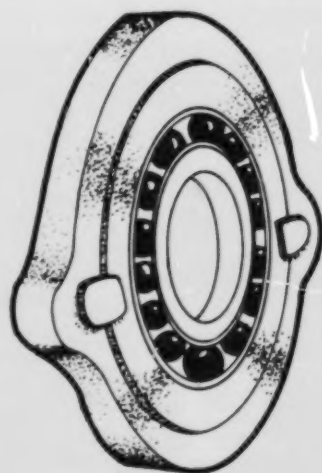
OPENING THE CRANKCASE



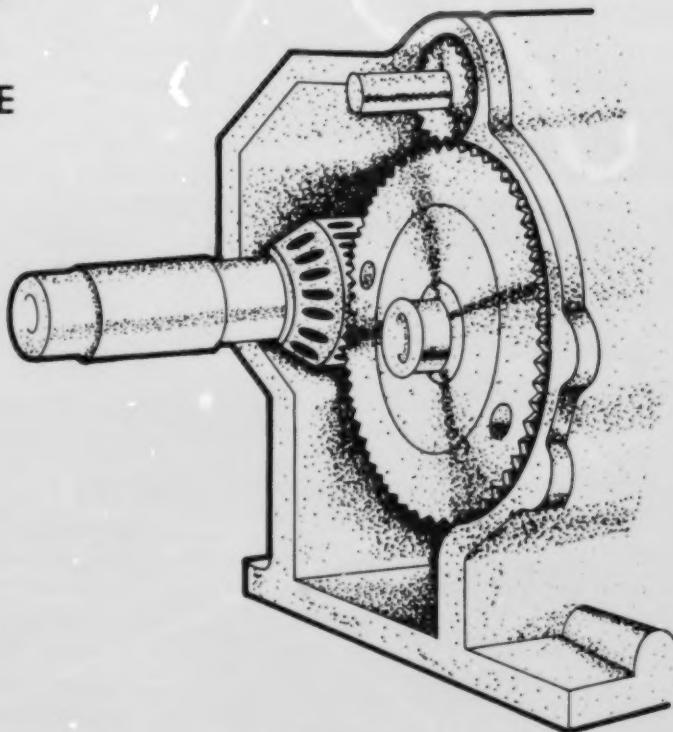
BEARING PLATE



BEARING SEAL

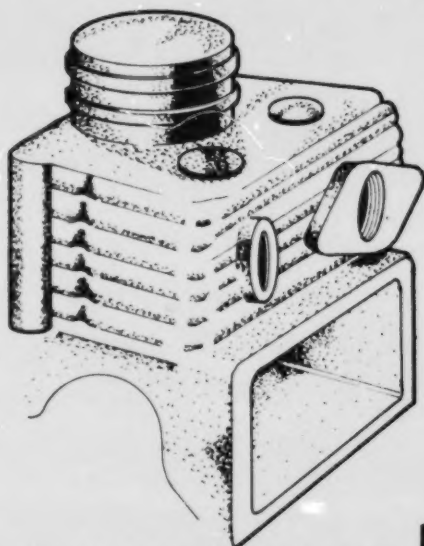


BEARING LOCKED ON
BEARING PLATE

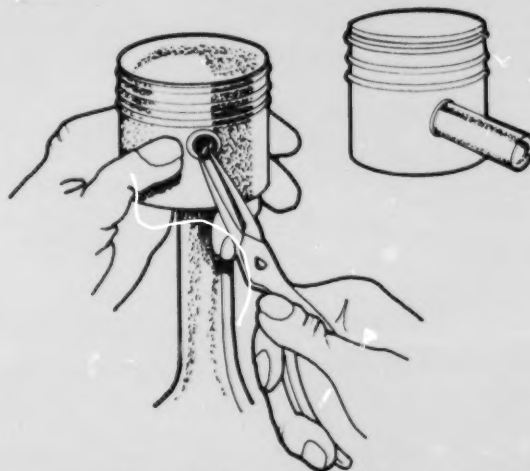


TIMING GEAR IN PLACE

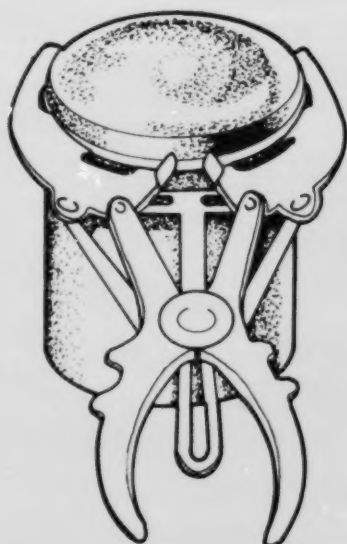
REMOVAL OF PISTON AND PISTON PARTS



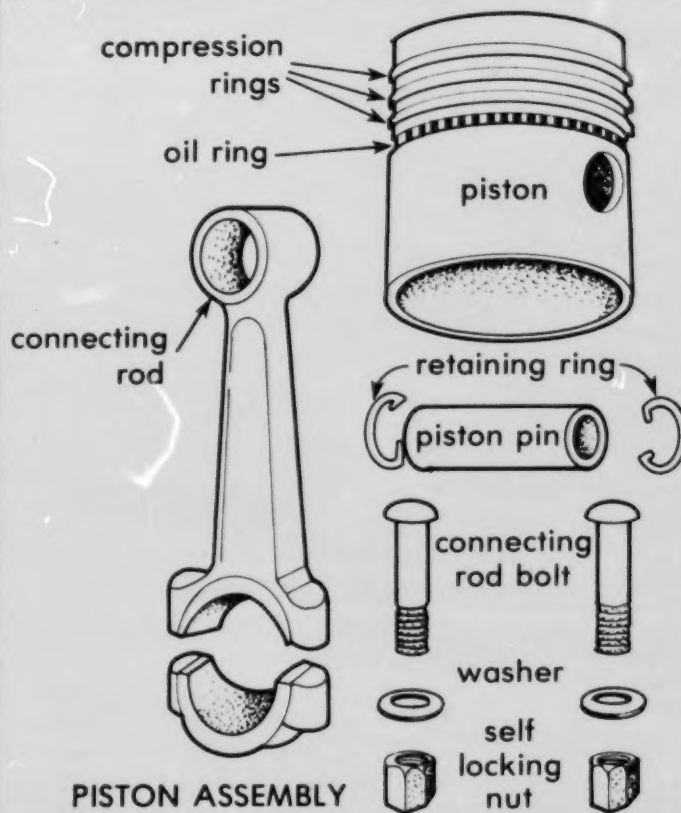
PISTON BEING REMOVED FROM CYLINDER



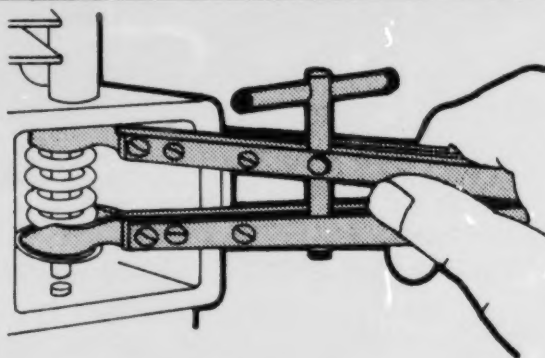
REMOVING RETAINING RINGS



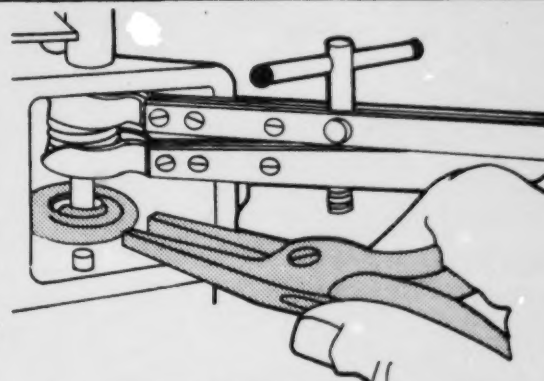
RING EXPANDER



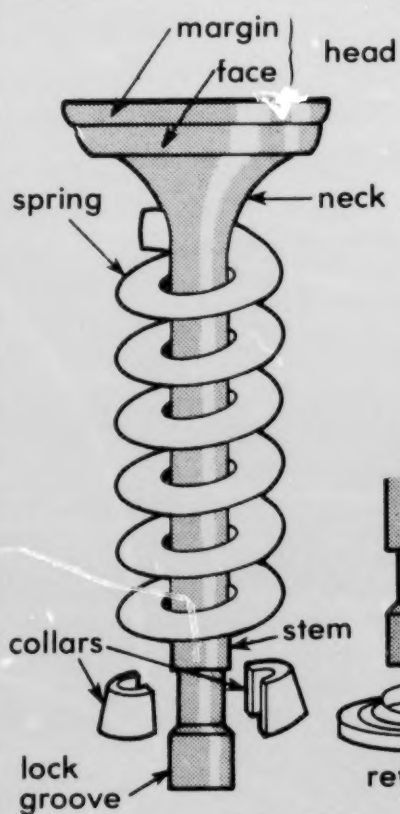
SMALL ENGINE VALVES AND CAM GEARS



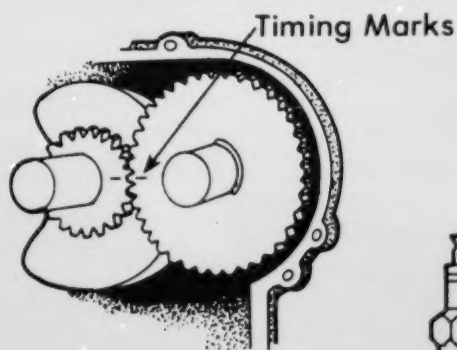
VALVE SPRING COMPRESSOR



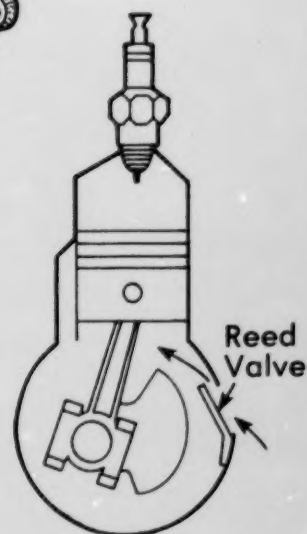
REMOVING RETAINER RING



VALVE ASSEMBLY

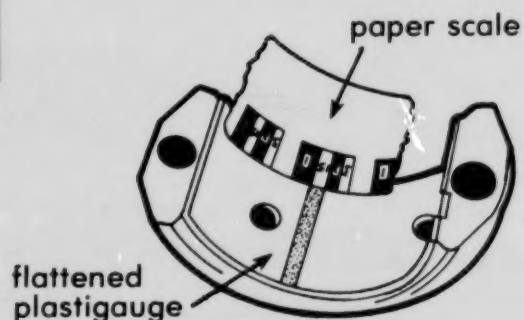
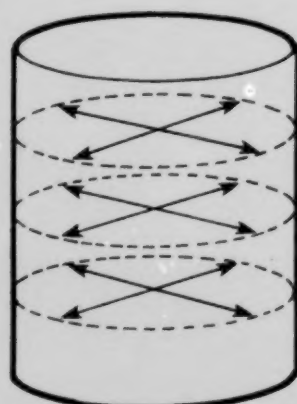
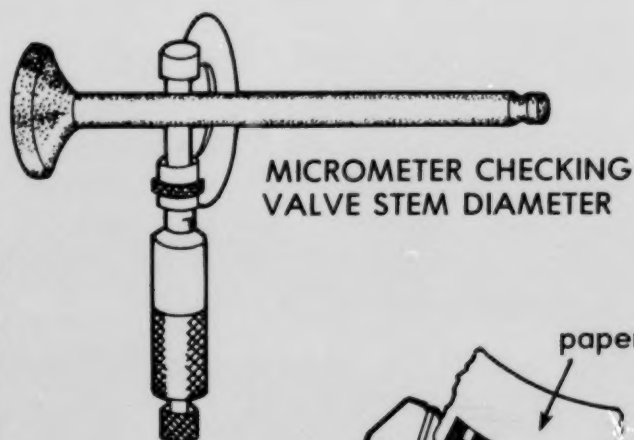
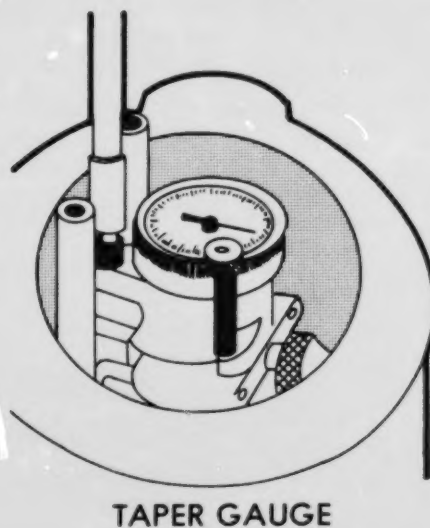
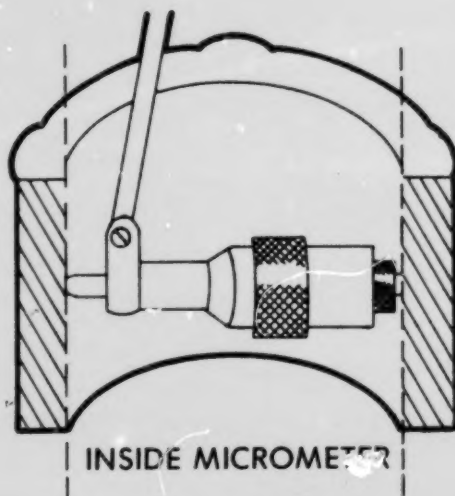


CAM GEAR
ALIGNED

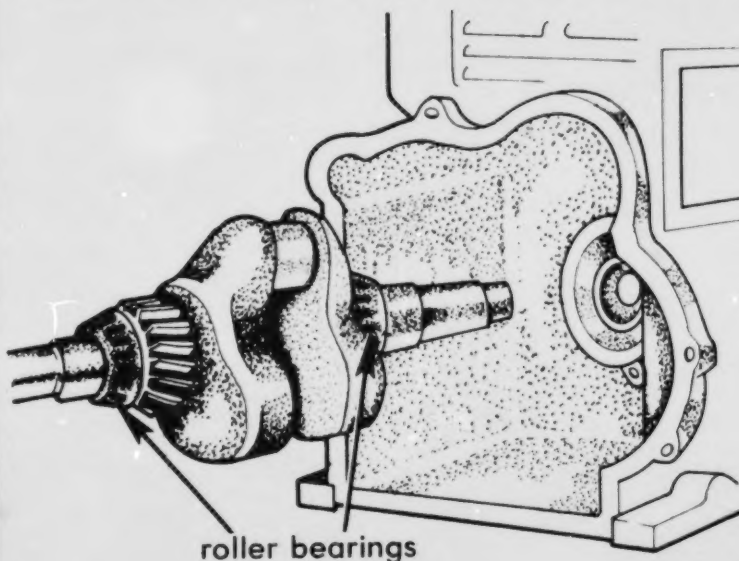


TWO-CYCLE
ENGINE

MEASUREMENTS USED ON SMALL ENGINES

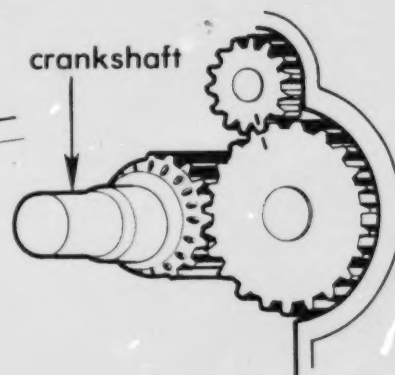


INSTALLING CRANKSHAFT, GEARS AND RINGS

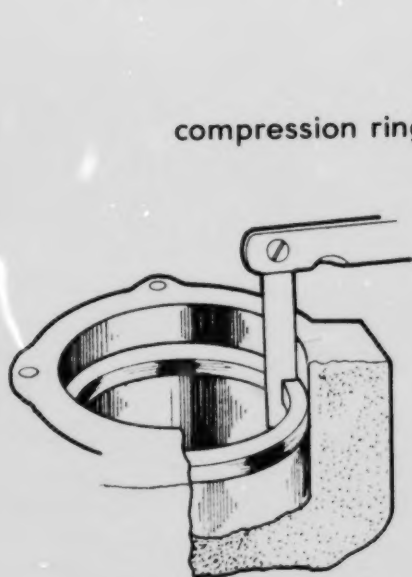


roller bearings

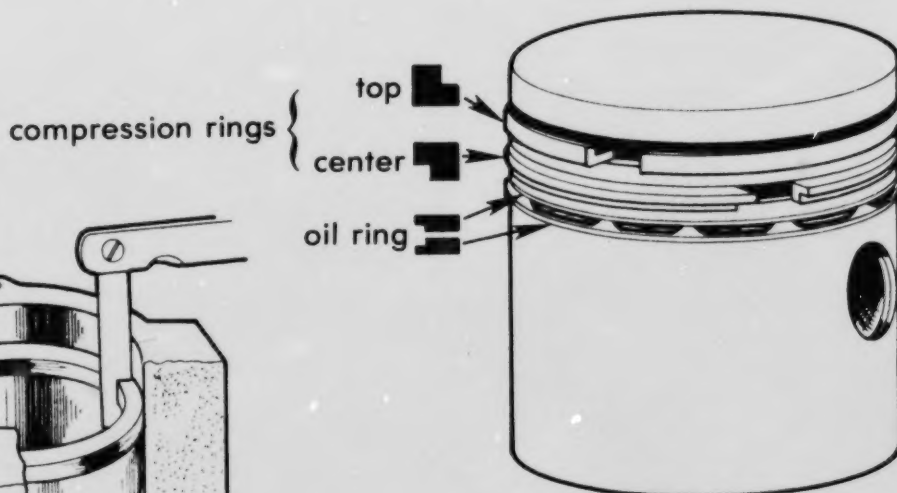
INSTALLING CRANKSHAFT



ALIGNING TIMING MARKS

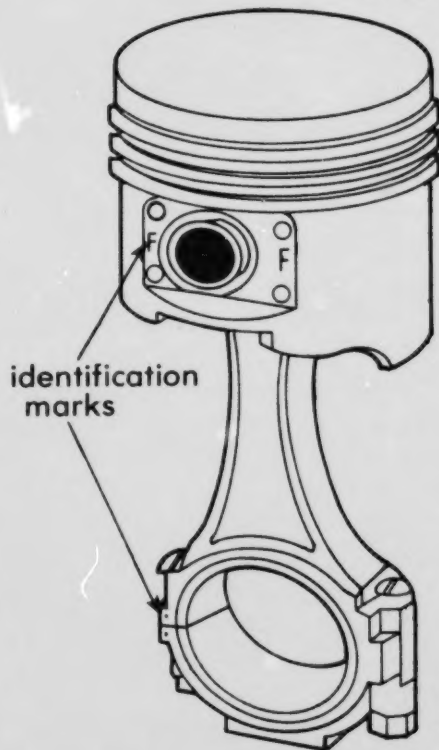


MEASURING NEW RING GAP

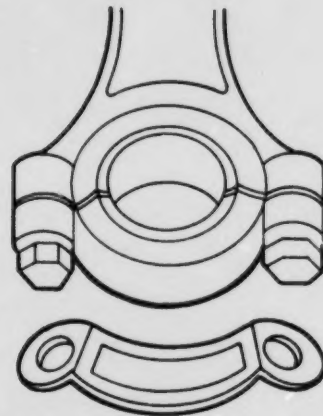


RINGS CORRECTLY INSTALLED

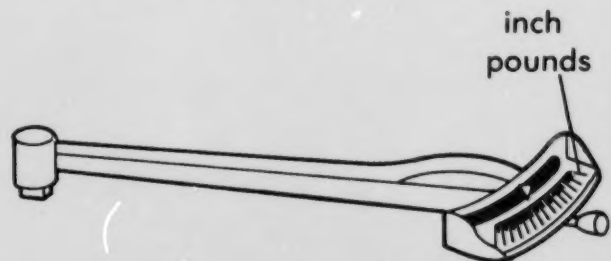
INSTALLING PISTON



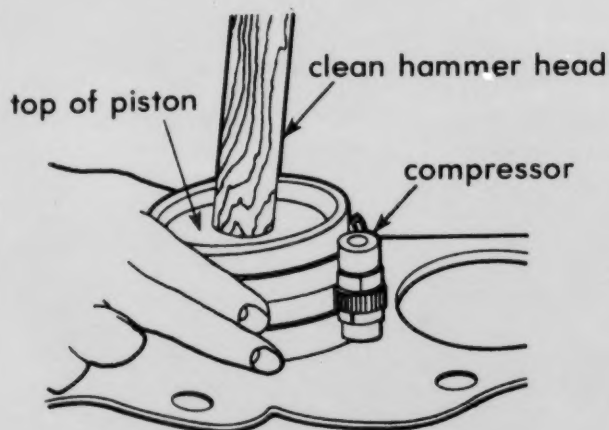
PISTON & ROD ASSEMBLY



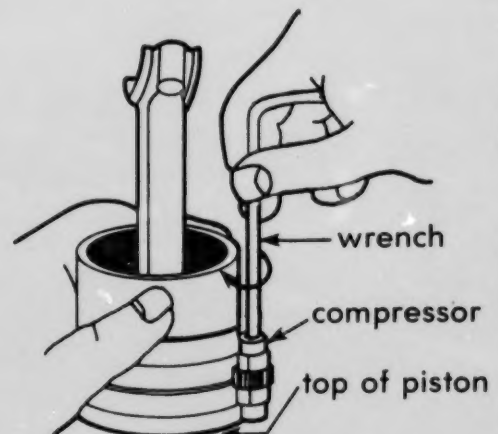
ROD LOCK PLATE & CAP



TORQUE WRENCH

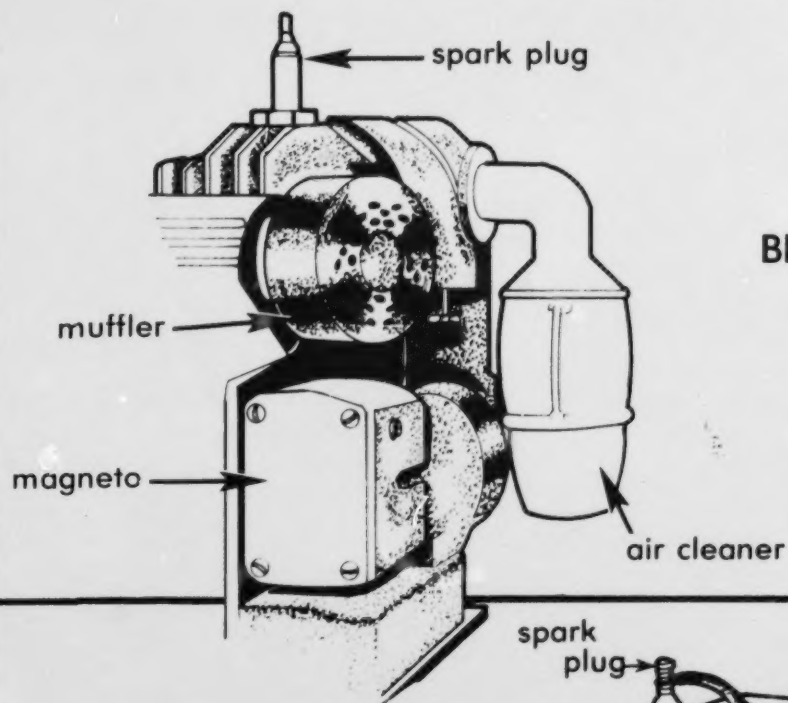


INSERTING PISTON
INTO CYLINDER



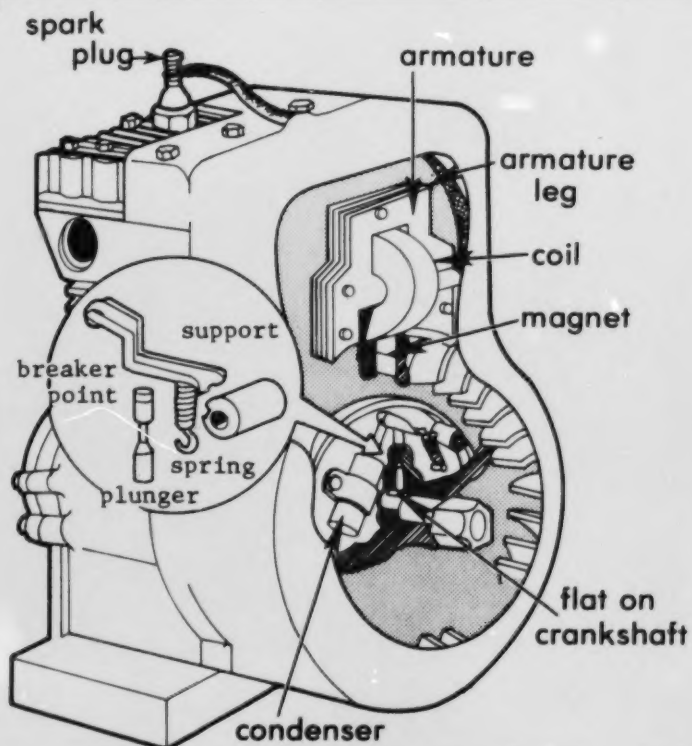
USING RING COMPRESSOR

IGNITION SYSTEMS



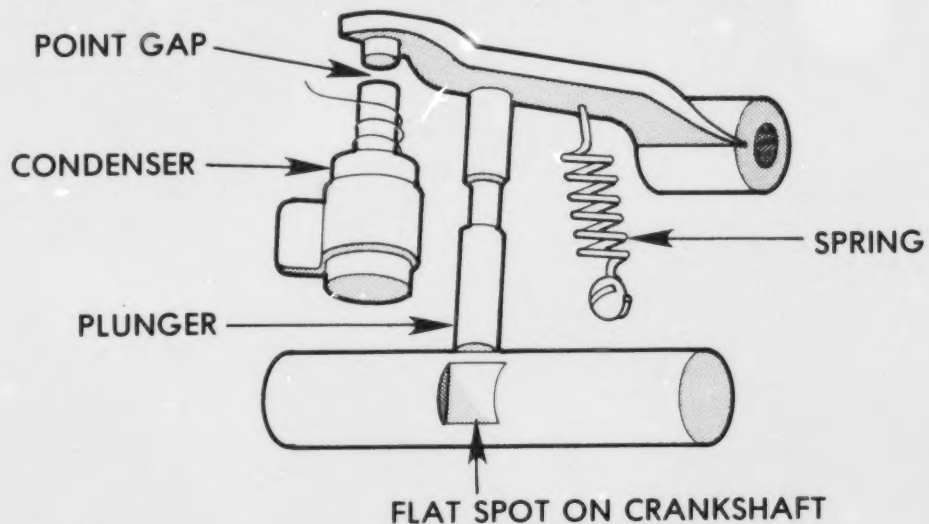
**BREAKER POINTS ON
SIDE OF ENGINE**

**BREAKER POINTS
UNDER FLYWHEEL**

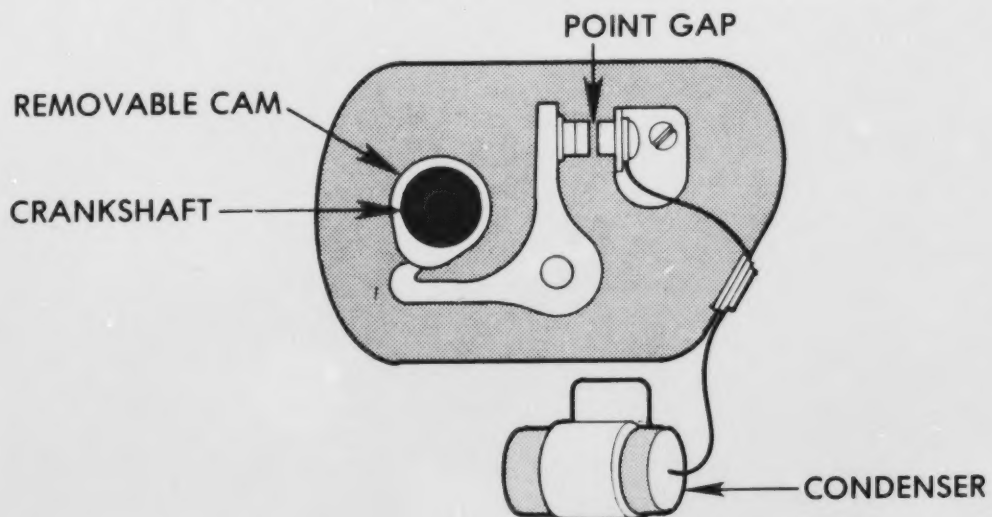


IGNITION SYSTEMS

POINTS OPENED BY CRANKSHAFT AND PLUNGER



POINTS OPENED BY CAM ON CRANKSHAFT



AGRICULTURAL MECHANICS

UNIT C: Tractor Maintenance

TOPIC 1: Operation

Suggested Procedures and Activities: The slide set "Operation and Daily Care" and transparencies will be helpful in presenting the topic. Large wall charts may also be used.

1. Importance of Proper Operation

All who drive a tractor should be tractor operators. An operator has the knowledge and skill to manipulate as well as take proper care of the tractor. A driver may have only the knowledge to run the tractor, but the operator can perform the following duties:

- a. Read the instruments and gauges properly.
- b. Check and service the cooling systems, oil level and lubrication points, air intake parts, and tires.
- c. Check loose, broken or worn parts that require the help of a mechanic.
- d. Read and use the operator's manual to develop a tractor maintenance program.
- e. Observe all safety rules for operating a tractor.
- f. Determine the type of jobs that can be successfully performed by the tractor.

2. The Importance of A Maintenance Program

Tractor manufacturers carefully plan and develop machines to give proper service on many different types of farm jobs. For example, a twenty horsepower tractor is made to pull light equipment. Whereas, a forty horsepower tractor has fewer limitations when handling different kinds and weights of equipment. The following practices may extend the life of the tractor.

- a. Keep the tractor under a shed when not in use.
- b. Lubricate all bearings periodically.
- c. A good grade oil of the proper viscosity should be used in the crankcase.
- d. Keep the radiator filled with antifreeze or clean soft water.

- e. The differential and transmission should be kept adequately full with a high quality oil.
- f. All instruments and gauges should be functioning properly at all times. Some makes of tractors are equipped with a combination meter. This meter gives the engine revolutions per minute, travel speed, PTO revolutions per minute, pulley revolutions per minute and hours of use.
- g. Keep the removable filters clean.

Transparency No. 1

- h. Use the tractor controls properly. They are:

Steering gear (wheel type)

Hydraulic control levers

PTO control lever

Right and left brake

Clutch pedal or lever

Manifold heat switch

Gear shift lever

Throttle lever

Steering clutch brakes (crawler type)

Brake latches

Pulley control lever

Light switch

Ignition switch

- i. Hitch implements properly to the tractor.
- j. Locate and remedy any operating trouble (s) promptly.
- k. Maintain the electrical system properly.

3. Safety Practices to Observe When Operating A Tractor

Transparency No. 1a

- a. The best time to form correct and safe operating habits is when the operator is learning to operate the machine. Usually the operator's manual is studied at this time. The manual warns against unsafe habits and explains how the operator may develop safe practices.

b. Each year new safety devices are designed and placed on the tractor and tractor equipment. These safety devices are designed to protect the operator and others. If they are removed or made inoperable, the chance of being injured becomes greater. Actually, the best type of safety device is the operator.

c. Safety rules to follow are:

Transparencies Nos. 2,3,4, and 5

- (1) Use the drawbar to pull a heavy load. The tractor may tilt backwards if the axle or seat bracket is used.
- (2) Drive the tractor at a moderate speed. Many tractor upsets are caused by high speeds to and from work.
- (3) Drive the tractor across ditches that have gradual slopes. The tractor may tilt backwards or sideways if driven into ditches with steep banks.
- (4) Drive at a slow tractor speed in tall grasses or weeds. A hidden rock, stump or log can cause the driver to fall off the tractor or might make a sudden turn.
- (5) Avoid driving along a steep slope. A small hole, bump or turn may cause the tractor to tilt sideways.
- (6) Use the tractor for only those jobs it's designed to do. Running errands and playing cowboy may cause a serious accident.
- (7) Drive with utmost care in mud and on slippery ground. Wheels stuck in the mud can cause an accident. The chassis may revolve around the axle when power is applied.
- (8) Work on attached equipment with the engine stopped, the tractor out of gear, and the brakes engaged. Such precautions may prevent an accident from occurring when hitching or working on attached equipment standing on a slope.
- (9) Use rear wheel weights when using a front end loader on a tricycle tractor to avoid having the tractor tip forward.
- (10) Consider the tractor as a one-rider vehicle. The operator should be the only person on the tractor when it is in operation.
- (11) Avoid heavy and high speed traffic. It pays to haul the tractor rather than have it exposed to traffic conditions.
- (12) Other safety rules to observe are as follows:
 - (a) Always start the tractor in neutral gear.
 - (b) Stop the engine and do not smoke when refueling the tractor.
 - (c) Never ride on the drawbar or dismount the tractor while it is moving.

- (d) Do not leave the engine running if the tractor is unattended.
 - (e) Wear snug fitting clothing when working around or on the tractor.
 - (f) Service the tractor with the engine stopped.
 - (g) Wait for a very hot engine to cool before adding water to the radiator.
 - (h) Ground the engine when doing belt work. The belt pulley should be motionless before putting on or removing the belt.
 - (i) Operate the tractor at night only if it is equipped with adequate lights and other warning equipment.
 - (j) Be sure that all safety and protection shields for moving parts and electrical wiring remain in place.
 - (k) Reduce speed and keep the tractor in gear when going down steep slopes or hills.
- d. Most tractor accidents are caused by the operator failing to recognize the approaching danger or by the operator's carelessness. Accidents may be reduced or eliminated completely if the operator observes the safety rules for operating a tractor.

Transparency No. 6

- e. A tractor is similar to any other moving vehicle, in two ways; it is not dangerous when operated properly, and it has a center of gravity. The weight of the wheel tractor is concentrated in front of the rear axle and midway between the rear wheels. The tractors will not likely tip over on a slope until the center of gravity is outside the rear tire, unless it is turning. The centrifugal force on a tractor making a turn is outward; therefore, a tractor may tip over on the side while making a turn at a high speed. A tractor may be upset at eight miles per hour on level ground.

4. Driving the Tractor

- a. Starting the Movement - The foot brakes must be unlatched before the tractor is put in motion. There are several different types of latch releases. Some of the most common are: pull rod, lever and toetrip. Some tractors have both brakes on one side, whereas others have a brake on each side of the engine.

Idle the engine before disengaging the clutch and shifting gears.

Disengage the clutch so that all power will be removed from the transmission, thus stopping the gears from rotating.

Shift the gear to the desired speed and engage the clutch. The rate of engine speed (quickness) for engaging the clutch will depend on the type and condition of tractor and the position the tractor is in at the time of movement. Clutches grab on some tractors, causing a sudden lunge forward.

A power shift can be shifted with the tractor in motion or on-the-go. The change in gear ratio is by a system of brakes and clutches that function together by hydraulic pressure. Change the gears one at a time.

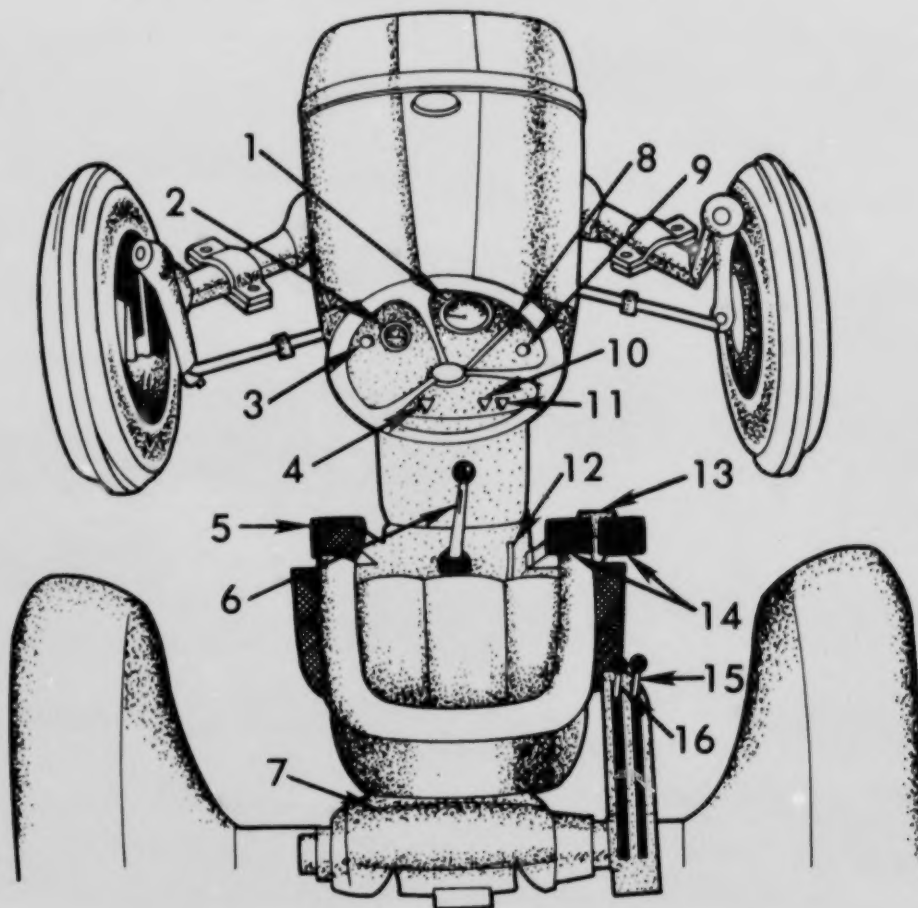
If the tractor is equipped with a hand-shift transmission, the gears should not be shifted while the tractor is in motion. Some tractors are equipped with "gearshift stations"; therefore, gears can be changed in the station while the tractor is in motion. The clutch disc and the transmission shaft must be stopped completely on most hand-shift tractors in order to avoid gear damage.

The tractor steering system is similar to an automobile. On most farm tractors a steering wheel is used to guide the front wheels. However, a tractor is equipped with individual brakes to assist the steering. A short turn may be made by braking one wheel.

- b. Stopping the Movement - Retard the throttle to reduce the engine speed. Press down firmly on the clutch pedal to disengage the clutch. Shift the gear to the neutral position. The brakes may aid in bringing the tractor to a complete stop. The brakes are locked by pressing the brake pedal down. The speed-control lever should be set at fast idle if the engine is left running.

-
1. "Gulf Farm Tractor Guide", Gulf Oil Corp., Houston, TX.
 2. Phipps, Lloyd J., Mechanics In Agriculture, The Interstate Printers and Publishers, Inc., Danville, IL.
 3. Promersberger, William J., Modern Farm Power, Prentice-Hall, Inc., Englewood Cliffs, NJ.
 4. "Tractor Operation and Daily Care", AAVIM, Athens, GA.
 5. "FMO Agricultural Machinery Safety", Deere & Company, Moline, IL.

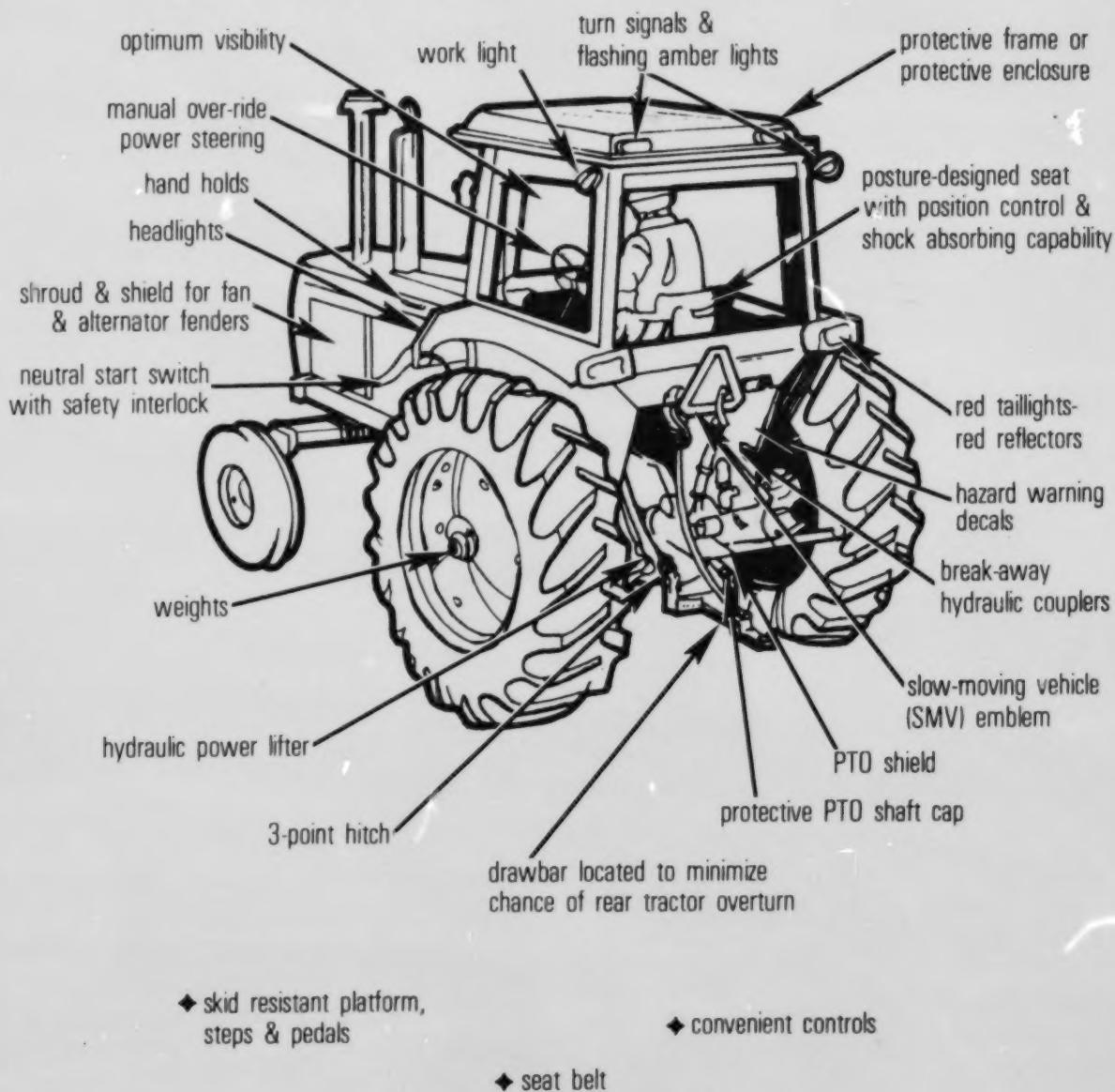
CONTROLS AND INSTRUMENTS



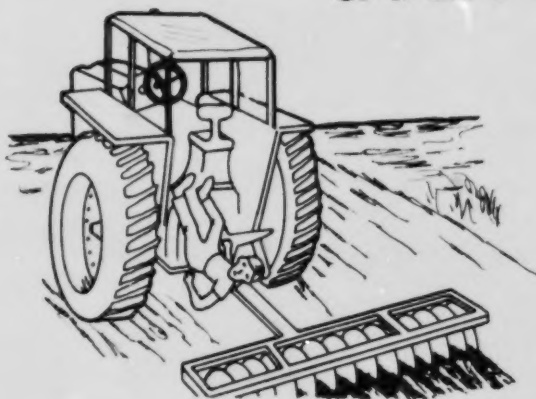
1. GAUGES-GENERATOR, FUEL,
OIL, TEMPERATURE
2. TACHOMETER
3. HORN
4. STARTER SWITCH
5. CLUTCH PEDAL
6. GEAR SHIFT
7. POWER TAKE-OFF
8. SPEED CONTROL LEVER

9. LIGHT SWITCH
10. IGNITION SWITCH
11. CHOKE
12. BRAKE PEDAL LOCK
13. BRAKE PEDAL LATCH
14. BRAKE PEDALS
15. LOAD LEVER CONTROL
16. AUXILIARY VALVE LEVER

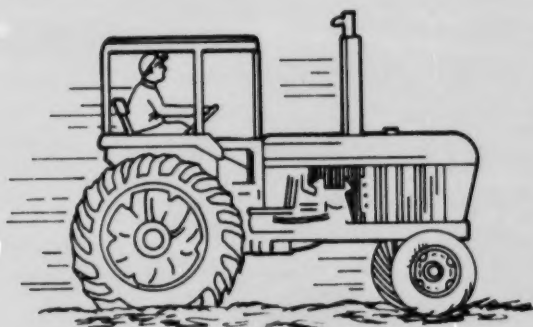
SAFETY FEATURES ON AMERICAN MANUFACTURED TRACTORS



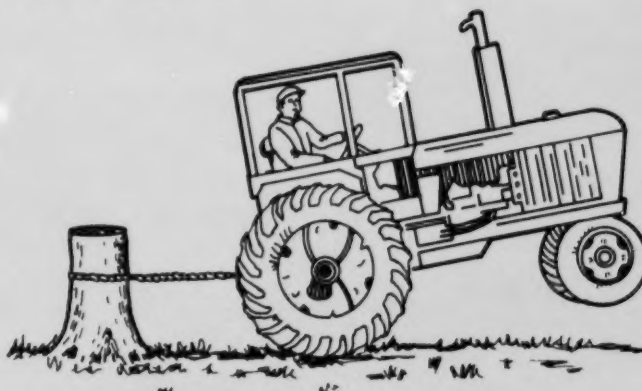
SAFETY PRACTICES



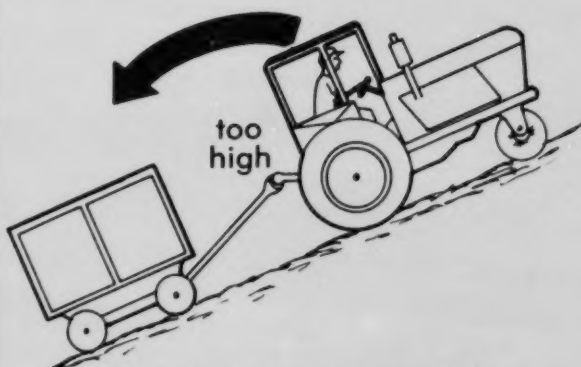
Do not ride on drawbar



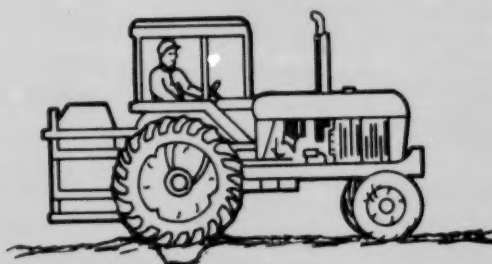
Do not drive tractors to & from work at high speeds



Improper use of the drawbar

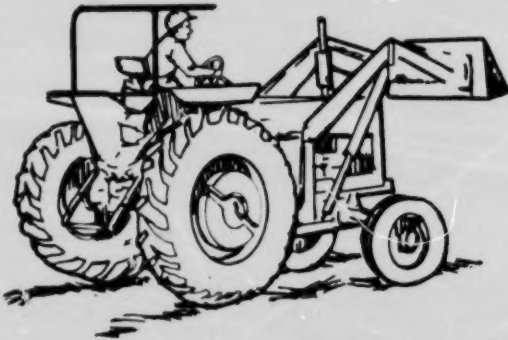


Incorrect attachment hitch



Do not drive fast over narrow ditches

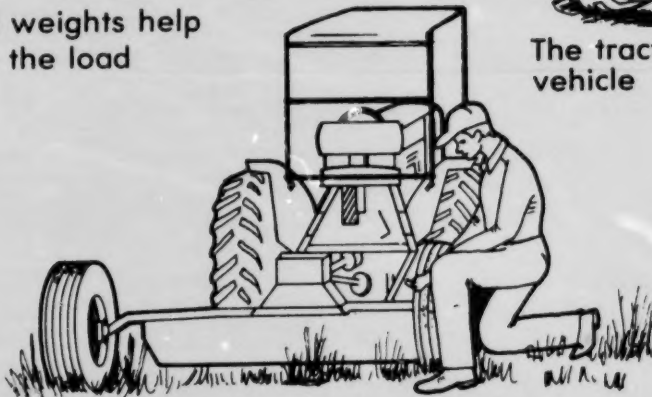
SAFETY PRACTICES



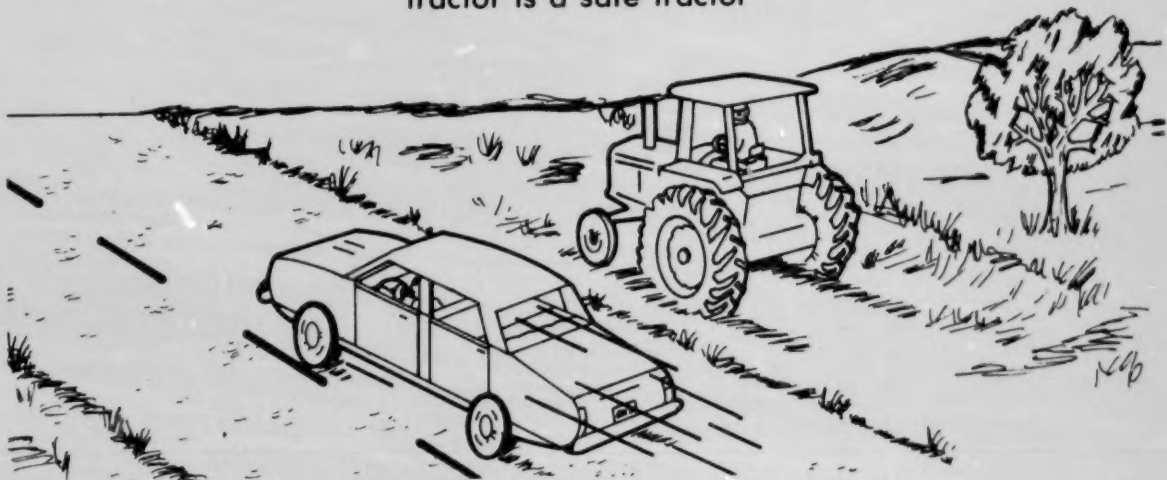
Rear wheel weights help
balance the load



The tractor is a one rider
vehicle

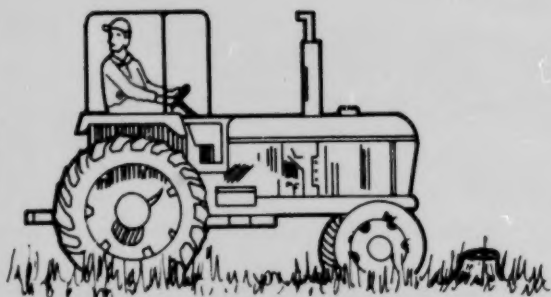


When working on equipment, a stopped
tractor is a safe tractor

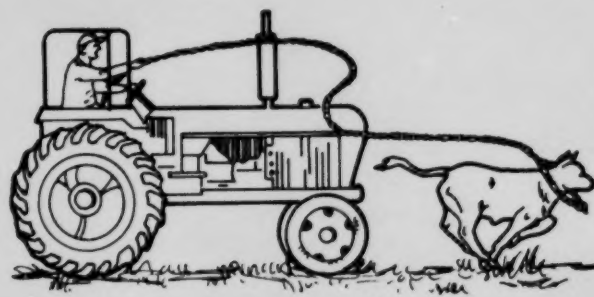


Avoid fast traffic

SAFETY PRACTICES



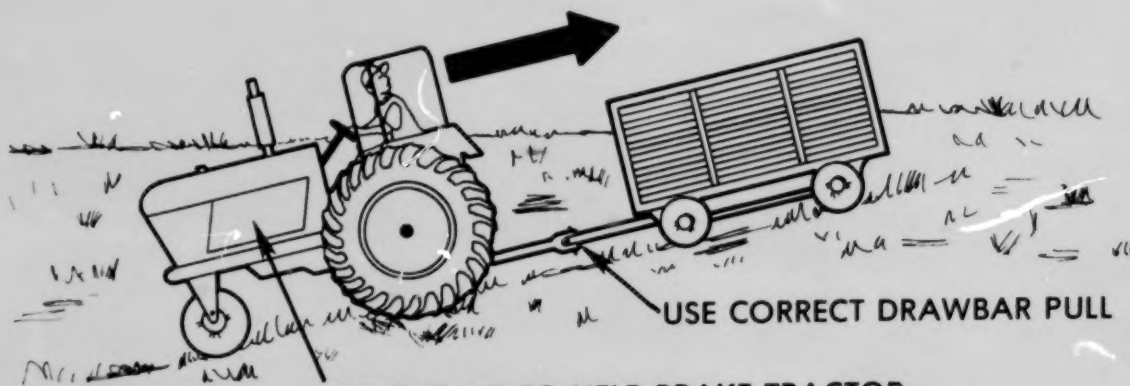
HIDDEN OBJECTS CAUSE ACCIDENTS



IMPROPER USE OF TRACTOR



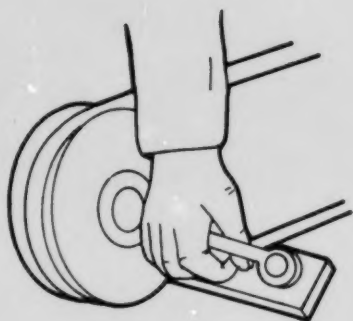
AVOID SLOPES



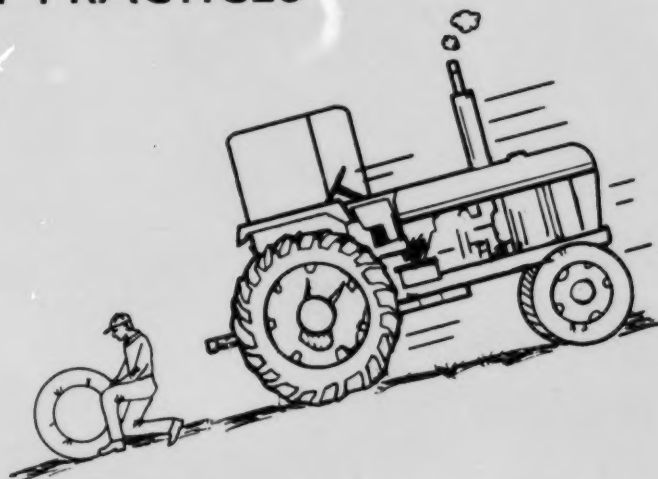
USE CORRECT DRAWBAR PULL

USE ENGINE TO HELP BRAKE TRACTOR

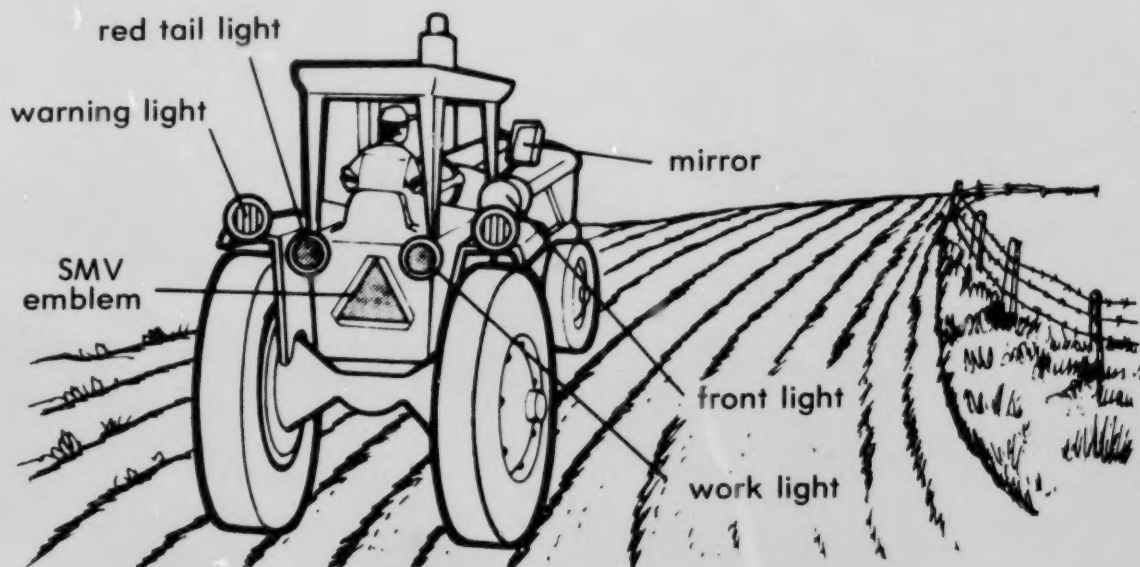
SAFETY PRACTICES



Never work near belt when
belt is in motion.

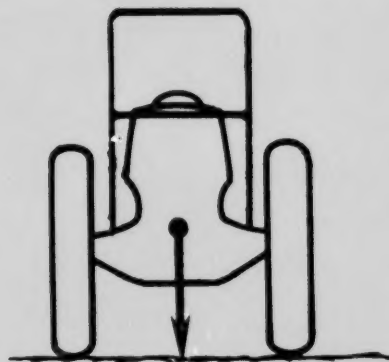
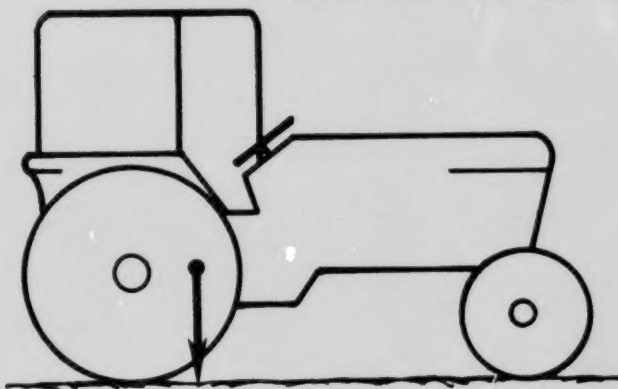


Do not park a running tractor



USING LIGHTS & MIRROR

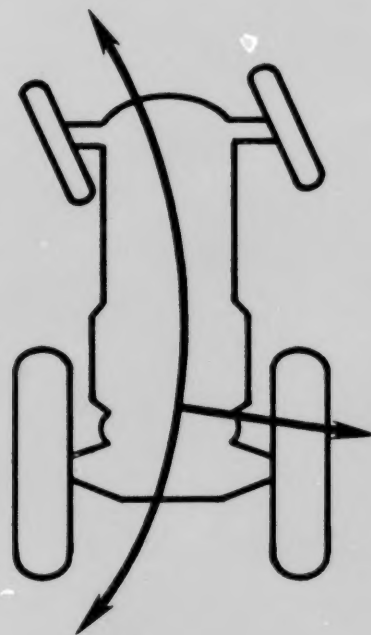
SAFETY PRACTICES



Center of Gravity



Tractor will tilt when center of gravity is outside rear wheel.



Centrifugal force is outward on the turn.

AGRICULTURAL MECHANICS

UNIT C: Tractor Maintenance

TOPIC 2: Daily Care

Suggested Procedures and Activities: Transparencies, filmstrips, and slide film can be used as teaching aids when presenting the lesson on daily care of a tractor. A tractor and large wall charts can also be used during the class discussion.

1. The Importance of Tractor Maintenance

A tractor is designed to give long and satisfactory service if it receives the proper care throughout its useful life. Many tractors remain in operation for twenty-five years and even longer.

In order for a tractor to give long service it must receive the proper daily care when it is being used. The best guide to follow for a good maintenance program is the operator's manual. This explains which parts need to be checked and serviced, according to the length of time the tractor is in operation. It may point out maintenance practices that should be observed at the beginning of each operational day.

2. Operation Devices Which Protect the Tractor

The tractor manufacturer provides instructions, instruments, and gauges to protect the machine while it is in operation. These devices identify troubles that appear in vital parts of the engine. The instruments and gauges relay messages, and a competent operator watches them while driving the tractor. The gauges and their functions are:

Transparency No. 1

- a. Heat Indicator - This gauge indicates the temperature of the liquid in the cooling system.
- b. Oil Gauge - This dial indicates the oil pressure which is regulated by the circulation of the oil.
- c. Ammeter - This dial points out any trouble in the circuits. It gives the amount of current flowing from the battery.
- d. Hour Meter - Most tractors are equipped with meters which indicate the number of hours of use.

Tractors are provided with special air cleaners, brakes, lights, guards, bearings, grease fittings, seals, wheel weights, filters, and many special gear ratios to make it one of the most protected machines in operation.

Yet, many tractors are disabled or destroyed through unnecessary wear, mechanical troubles, collisions, breakage, and plain crack-ups.

3. Special Care Practices

- a. All tractors have certain parts that need daily attention. Most of these parts are checked every ten hours (daily) the tractor is operated. Under certain conditions some parts of the tractor are checked every five hours. For example, a tractor operating in mud or on a very dusty location should be checked more often than one operating under normal conditions.
- b. A new or overhauled tractor requires a different kind of daily care from one that has been in service for several months.

A new or overhauled tractor should be operated at less than one-half load at full throttle for the first ten-hour period. For the second ten hours, it is to be operated at one-half load. The new or overhauled tractor should be operated at about one-half load for five to six ten-hour periods before operating at a full load.

The engine on a new or overhauled tractor should not be idled for a long period of time. Damage may occur to the cylinder walls or rings due to insufficient lubrication. A corrected fast idle speed should eliminate overspeeding of the engine. A new or overhauled engine should not be overspeeded.

- c. Before a tractor is put under a full load, it should be allowed to warm up. The warm-up period is most important if there is a high moisture content in the air or if the weather is very cold. Even during warm weather, it is advisable to idle the engine a few minutes before operating the tractor at a full load. Much of the engine wear occurs between the time the engine is started and the time it reaches the proper operating temperature. It may take the tractor twenty to thirty minutes to reach a proper operating temperature of 180° to 190°.

4. Daily Care Practices

Transportation vehicles are usually serviced according to the miles covered. Tractors are serviced according to the number of hours they have been run. Most of the same operating parts will be checked during each check period. The most important service periods and services performed are:

Transparencies Nos. 2, 3, and 4

- a. After the first 10 hours of operation

Check the crankcase oil level, liquid in the cooling system, and fuel tank.

Check the fan, generator, and water pump belts.

b. After each succeeding 10 hours of operation

Check the crankcase oil level.

Lubricate fittings that require lubrication (steering, brake, and clutch pedals, etc.).

Clean air cleaner - Dry or oil type.

Check the water level in the radiator. If the coolant is low, fill to about two inches below the neck.

Check the pressure in the tires. The change in weight of tractor equipment will make it necessary to change the air pressure.

Check the fuel level in the tank. Full tanks collect less moisture than empty tanks.

Check tractor for broken and worn parts, loose nuts, and bent brackets.

Transparencies Nos. 5, 6 and 7

c. After 50 hours of operation

Check fan shaft bearings and water pump bearings for lubrication. Lubricate these bearings according to the manual directions.

Check crankcase oil, drain oil, and refill.

Check hydraulic fluid filter and replace element if necessary.

Check pneumatic tires for proper pressure.

Check radiator core, water pump, and fan and generator belts.

Check flexible rubber connections for loose fitting or leakage and V-belts.

Check and tighten cylinder head bolts with torque wrench on LP gas engines.

Check the fluid level in the battery.

Check and lubricate clutch release mechanism.

Check and service dry-type air filter.

Transparencies Nos. 6 and 7

d. After 100 hours of operation

Check the crankcase oil and replace oil filter with oil change. In some tractors it is recommended the oil and filter be changed every two weeks.

Check and lubricate the clutch pedal, brake pedals, and clutch release bearings.

Check the cylinder head bolts and tighten to proper torque. Also, check valve clearance.

Check and clean cylinder head breather caps.

Check the crankcase breather and clean or replace it.

Transparencies Nos. 7 and 8

e. After 250 hours of operation

Check, drain and refill crankcase.

Check and clean fuel sediment bowl.

Check and clean hydraulic screen and replace filter.

Check and replace lubricating oil filter.

Check and lubricate all points.

Check the brakes and clutch for adjustment.

Check and adjust spark plugs.

Check breaker points and adjust and clean chamber.

f. After 500 hours of operation

Check and repack the front wheel bearings.

Check hydraulic system and change oil.

Check the steering gear housing and change the oil.

Check the cooling system, drain, and refill.

Check the timing of the tractor.

g. After 1000 hours of operation

Check transmission, differential and final drives. Drain and refill these parts.

Check all other parts and make tune-up adjustments.

5. Results of Inadequate Maintenance

a. Dirty air cleaners

b. Dirty crankcase breathers

c. Low tire pressure

- d. Low liquid level in battery
- e. Improper valve adjustment
- f. Ignition points pitted
- g. Dirty spark plugs out of adjustment
- h. Dirty crankcase oil
- i. Liquid low in radiator
- j. Brakes out of adjustment
- k. Dirty fuel pump sediment bowl
- l. Bearings lack lubrication
- m. Hydraulic oil level low
- n. V-belts loose

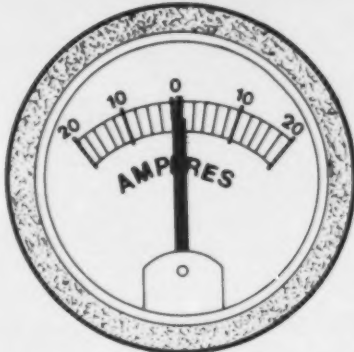
6. Storage and Specific Uses

- a. The tractor should be placed under a shed when it is not in use. Weather conditions such as high humidity, rain, sunlight, and even strong wind that moves dust can affect exposed tractor parts. Plastic, paint, rubber, and fibers are affected by weather conditions.
- b. Tractors are made to perform specific types of jobs and they should not be used to perform work that will endanger the future use of the machine.
- c. If a tractor is not cared for properly, the maximum horsepower will be reduced and the fuel consumption will increase. Proper care of a tractor will save money and avoid costly breakdowns.

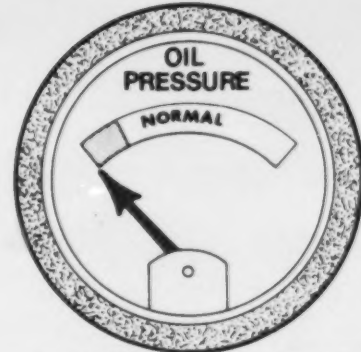
References:

- 1. "Instructions in Farm Mechanics", U.S. Department of Health, Education, and Welfare, Office of Education, Washington, D.C.
- 2. Promersberger, William J. and others, Modern Farm Power, Prentice-Hall, Inc., Englewood Cliffs, NJ.
- 3. Stone, Archer A. and Harold E. Gulvin, Machines for Power Farming, John Wiley and Sons, Inc., New York, NY.
- 4. "Tractor Maintenance-Principles and Procedures", AAVIM, Athens, GA.
- 5. "Tractor Operation and Daily Care", AAVIM, Athens, GA.
- 6. "FMO Preventive Maintenance", Deere & Company, Moline, IL.

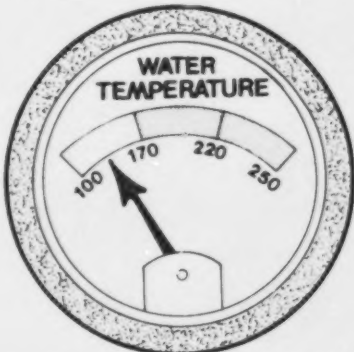
GAUGES TO AID IN OPERATION



AMPERES GAUGE



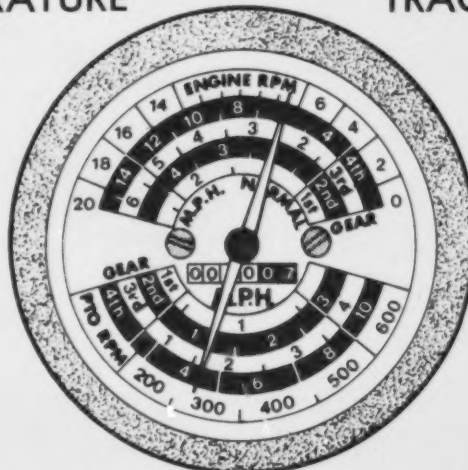
OIL PRESSURE GAUGE



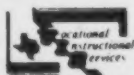
WATER TEMPERATURE
GAUGE



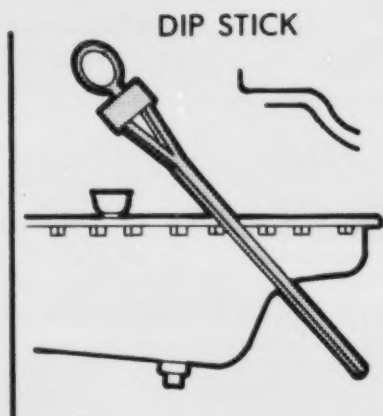
TRACTION BOOSTER
GAUGE



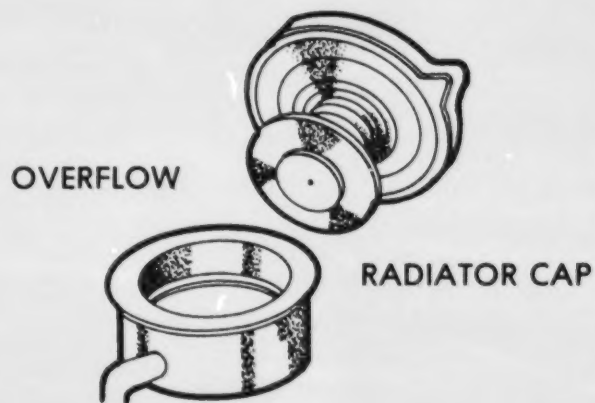
REVOLUTIONS PER MINUTE, MILES PER HOUR
AND HOUR USE GAUGE



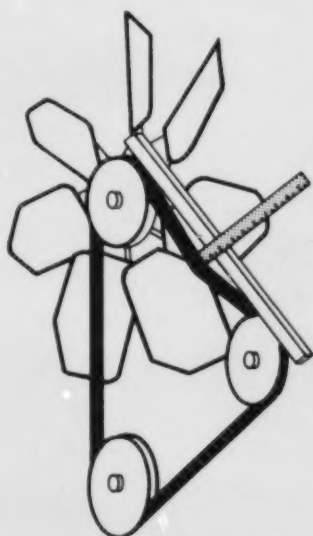
PERIODIC MAINTENANCE CHECKS



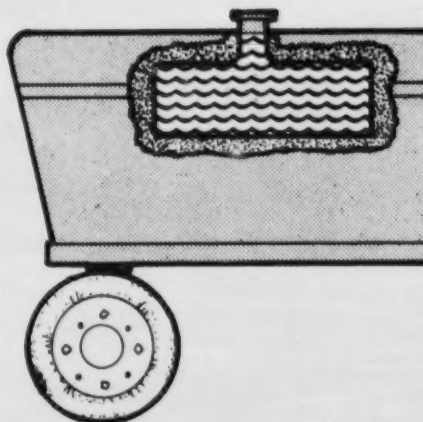
CRANKCASE OIL LEVEL
MAINTAINED



RADIATOR LIQUID LEVEL
MAINTAINED

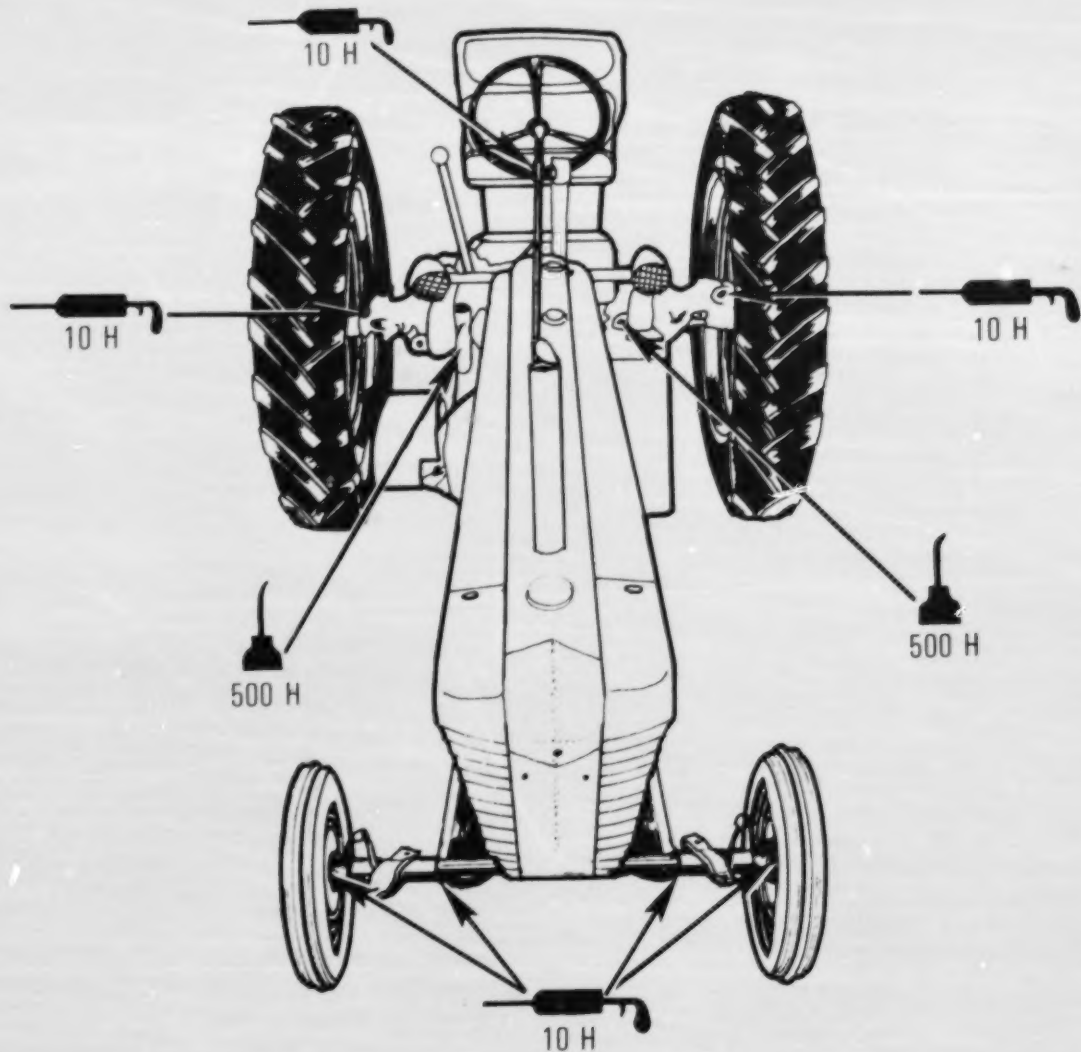


BELT TENSION

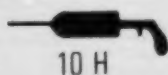


FUEL TANK FILLED AT
END OF DAY

LUBRICATION ACCORDING TO HOUR USE



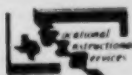
SYMBOLS



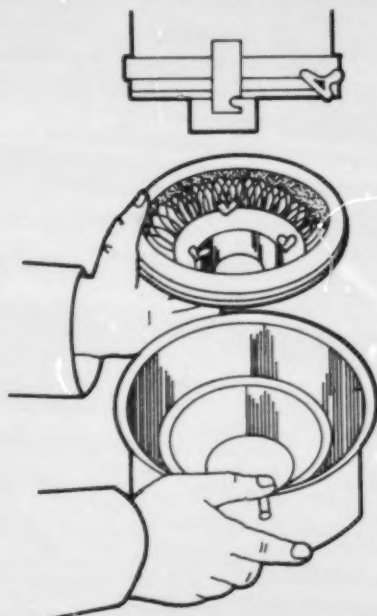
grease every 10 hours
of operation



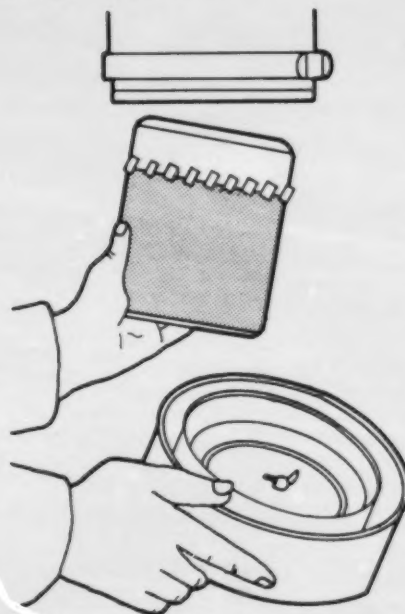
oil every 500 hours
of operation



CHECK FILTERS AND TIRES



OIL-TYPE AIR FILTER



DRY-TYPE AIR FILTER



PROPERLY INFLATED
TIRE

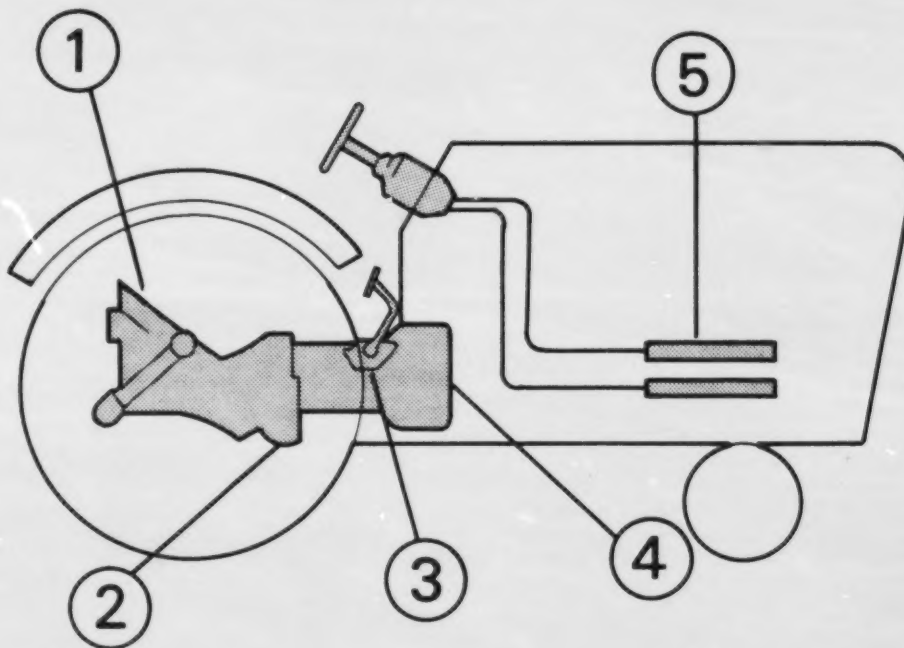


OVER INFLATED
TIRE



UNDER INFLATED
TIRE

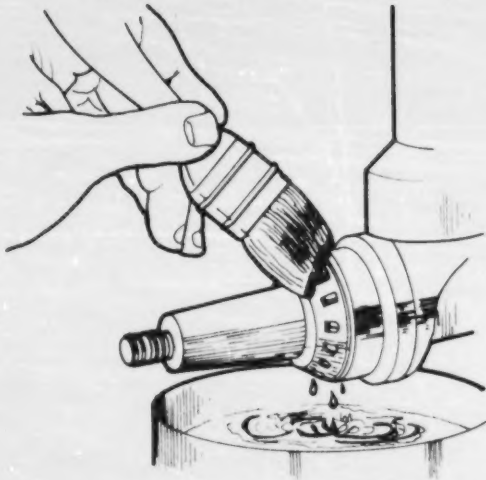
TRACTOR HYDRAULIC UNIT



1. Control System For Implements
2. Transmission
3. Power Brake Unit
4. Torque Converter
5. Power Steering Unit

FRONT WHEEL BEARINGS AND COOLING UNIT

CLEANING AND PACKING FRONT WHEEL BEARINGS

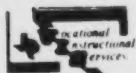
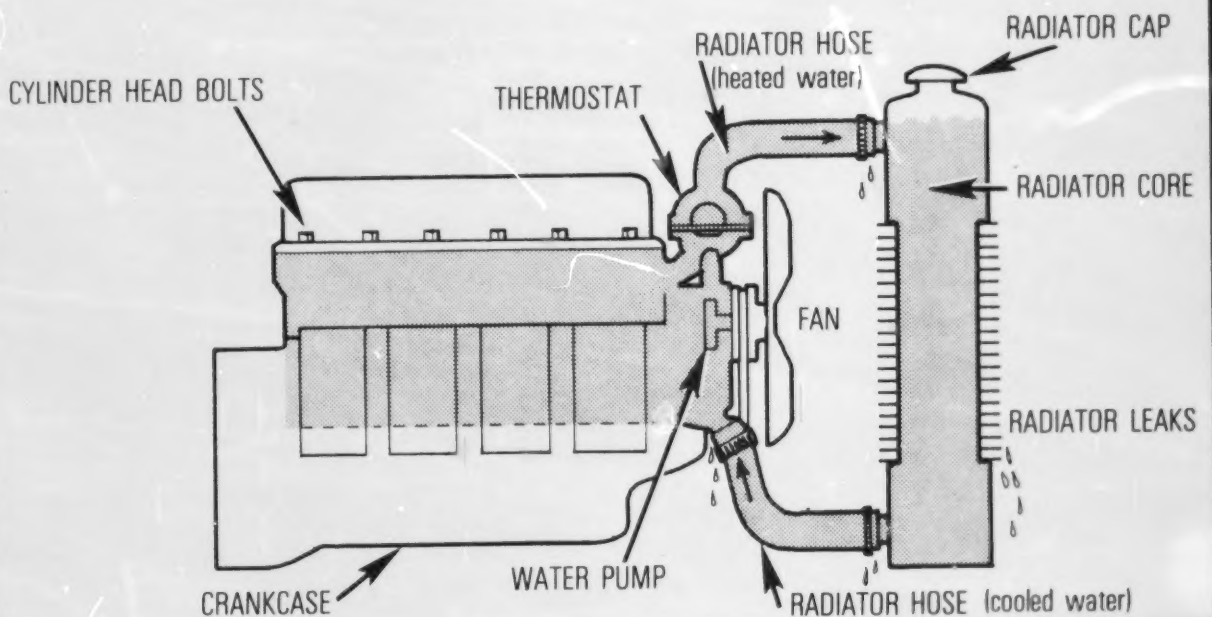


clean inner bearing

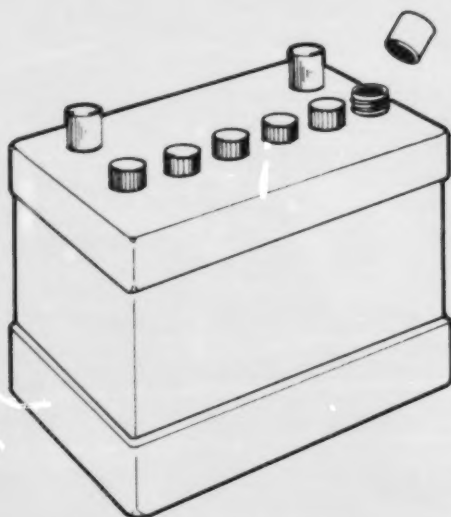


work grease into bearing

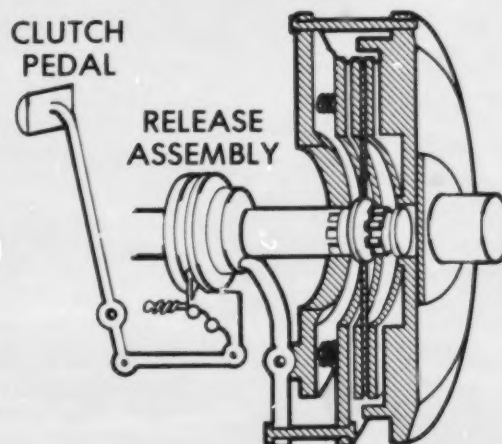
CHECKING THE COOLING SYSTEM



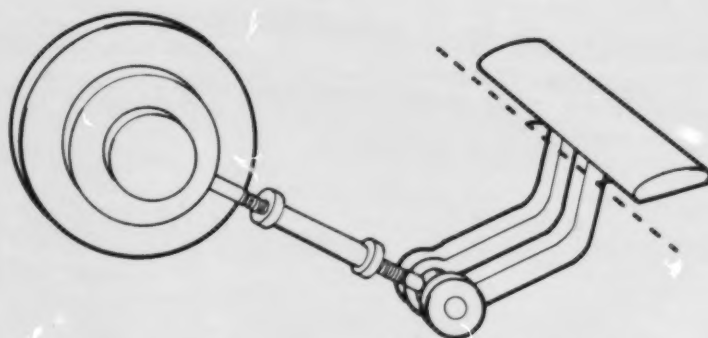
CHECKING BATTERY, CLUTCH, BRAKES AND SEDIMENT UNIT



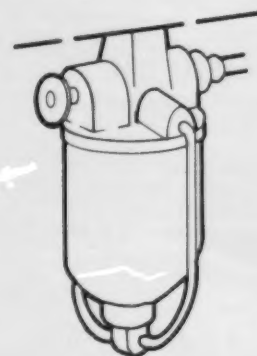
BATTERY FLUID



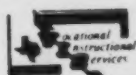
LUBRICATE CLUTCH RELEASE
MECHANISM



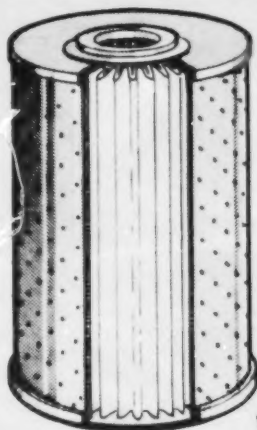
BRAKE ADJUSTMENT
AT CONTROL ROD



CLEAN FUEL SEDIMENT
UNIT

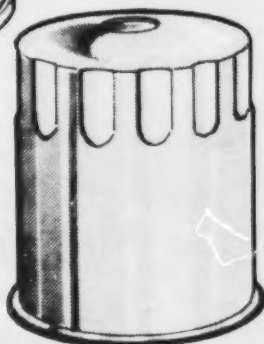


CHANGING OIL FILTER AND ADJUSTING SPARK PLUGS AND IGNITION POINTS

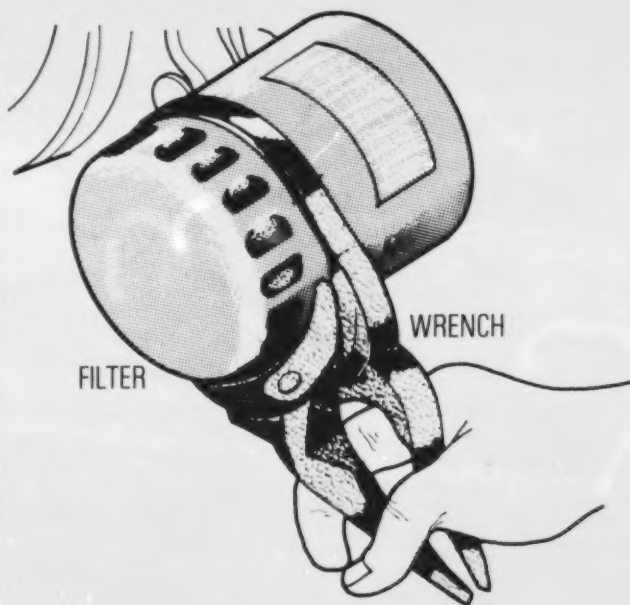


PAPER ELEMENT OF
SURFACE FILTER

DISPOSABLE
FILTER



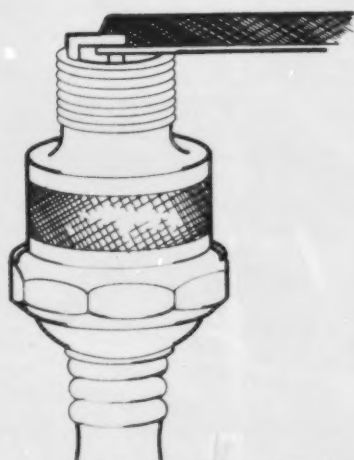
OIL FILTERS



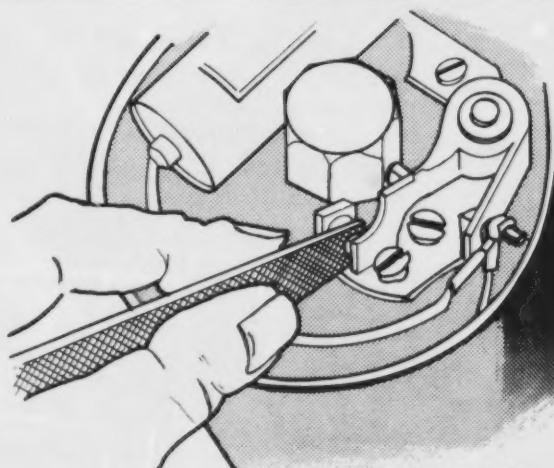
FILTER

WRENCH

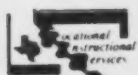
REPLACING DISPOSABLE FILTER



ADJUST SPARK PLUGS



ADJUST BREAKER POINTS



AGRICULTURAL MECHANICS

UNIT C: Tractor Maintenance

TOPIC 3: Servicing Air Cleaner Assembly

Suggested Procedures and Activities: Disassembled oil and dry-type air cleaners will be helpful in discussing the servicing of air cleaners. Transparencies may also be helpful as a teaching aid.

1. The Purpose of the Air Cleaner

The air cleaner is one of the most important parts of standard equipment found on a tractor. It furnishes clean air to the engine by preventing dust, chaff, and other foreign material from passing through the carburetor, manifold, intake valves, and into the cylinders.

Air free of abrasive particles reduces the wear on cylinder walls, piston rings, rod bearings, and valves. If these abrasive particles are not removed, damage is done to the engine before the dust reaches the oil stream, where it is removed by the oil filter.

A tractor may use as much as 9,000 gallons of air per gallon of fuel under normal operating conditions. All air enters the carburetor after passing through the air cleaner.

Transparencies Nos. 1 and 2

2. Types of Air Cleaners

a. Oil-Bath Type - This is the most common type of air cleaner found on modern tractors. The method in which the cleaner functions is as follows:

- (1) The incoming air flows into the cleaner oil cup.
- (2) Air forced on the oil causes a mixture of air and oil spray to be carried up into the separating element. The element is made up of baffles and metal mesh.
- (3) The fine dust particles carried by the air are trapped by an oil film as the air changes directions many times in the separating element.
- (4) The dust particles are washed from the screen into the oil cup by the oil spray.
- (5) The dirt particles settle to the bottom of the cup as the clean air passes upward through the filtering element into the engine.

Oil bath type air cleaners are found on tractors that require a large amount of air for operation.

- b. Dry Type Air Cleaners - The dry type air cleaners are either attached to the carburetor or manifold. The filter medium is either heavy treated paper, layers of cloth, or felt. The filtering area is increased in the filtering element by the material being folded like an accordion. Clean air is produced in the dry type cleaner in the following manner:

- (1) Air enters the element through an air inlet.
- (2) The design of the element fins causes the air to circulate in a centrifugal motion around the element.
- (3) As the air reaches the bottom of the element, the dirt is separated from it and deposited into the dust cup.
- (4) As the air flows through the filter element, material and the remainder of the dirt is removed.

Dry type air cleaners were used only on small engines several years ago, but recently they are found on some of the larger type engines. The parts of the air cleaner are: inlet pipe, air cleaner body, filter element fins, baffles, and dust cup.

Many tractors are equipped with a pre-cleaner. Usually the pre-cleaner is located at the end of a pipe. They remove the large particles of dust, depositing the particles in a collector bowl before they pass into the main cleaner. The pre-cleaner extends the cleaning intervals by reducing the load on the main air cleaner.

3. Advantages and Disadvantages of Using the Dry Type Air Cleaner

- a. This type of cleaner does not require cleaning as often. An oil-bath type cleaner is cleaned daily (each ten hours), whereas the dry type cleaner may be cleaned at 50-hour intervals.
- b. The element may be cleaned with air and/or water. It is not necessary to use a solvent to clean the air cleaner; therefore, it is not as messy as cleaning an oil-bath type filter.
- c. There is less danger of lint or chaff clogging the air passages.
- d. In case the filter is not serviced as recommended, the air movement through the filter may be restricted, causing the engine to lose power, give off black smoke, and use more fuel.

If the tractor is equipped with an air cleaner restriction gauge, it will indicate when the air cleaner needs servicing.

4. Servicing the Oil-Bath Type Air Cleaner

The steps to follow in servicing the oil-bath type air cleaner are:

- a. In order to prevent dust particles from being drawn into the engine, it must be stopped before the air cleaner is serviced.

- b. The oil cup is removed and inspected for dirt deposit. If the accumulation of dirt is about one-fourth inch deep or the oil appears heavy, the cup should be emptied and refilled with the proper grade of oil. It is necessary to fill the cup to the proper oil level after it has been cleaned.
- c. The bottom of the screen should be inspected for an accumulation of chaff and other foreign material. The foreign material should be removed before replacing the oil cup.
- d. The entire air cleaner should be removed at least once per year and thoroughly cleaned with kerosene or fuel oil.

The oil-bath type air cleaner should be inspected after each ten hours of operation. It is a good practice to inspect the air intake stack at the same time the oil cup is being inspected.

Transparencies Nos. 3 and 4

5. Servicing the Dry Type Air Cleaner

The following steps should be followed in servicing a dry type air cleaner:

- a. The engine must be stopped before servicing the air cleaner. If not, dirt or dust can be drawn into the engine while the filter element is being removed.
- b. If the air cleaner is equipped with a rubber valve (dust unloader), it should be opened to release dust particles. If the dust unloader is damaged, it should be replaced.
- c. It may be necessary to remove the hood or grill in order to provide access to the air cleaner.
- d. The dust on the exposed end of the air cleaner should be wiped off with a rag before removing the element.
- e. The end cap may be held in place by a hand screw or a clamp. The screw or clamp is removed to free the cap.
- f. A clean rag should be used to wipe the area around the element and to remove the dust from both the cap and baffle, if end cups are found on the air cleaner.
- g. If the rubber gasket on the end of the filter element is damaged, the entire filter element must be replaced.
- h. After the filter element is removed and examined for defects, it should be cleaned, unless the element is to be replaced. The methods of cleaning the filter element are:
 - (1) Tap the element to loosen the dirt. Shake the element to remove the loose dirt.
 - (2) Place the nozzle of a compressed air hose about one inch from the filter element and rotate the element until it is clean.

The nozzle pressure should not exceed 100 pounds per square inch.

Wash the element with water and detergent. First, clean away dirt with water or air and then wash with warm water and detergent. Rinse the element with clean water and allow 24 hours for drying.

Reassemble air cleaner in the reverse order of disassembly.

6. Servicing the Oil-Soaked Element Type Air Cleaner

Transparency No. 5

The oil-soaked element type air cleaner is found on small tractors or engines that require a large amount of air. It is not considered to be a major type of filter. This type does not clean as well as the oil-type filter and consequently there is limited use of it.

The steps in servicing the oil-soaked element type air cleaner are:

- a. The engine must be stopped while servicing the air cleaner.
- b. The oil-soaked filtering element is removed and washed in a safe solvent. Dust particles are removed from the fibrous element in the process of washing.
- c. Excess solvent is removed by shaking the element after washing. The element should be allowed to dry thoroughly before soaking it in oil.
- d. The filtering element is replaced in the same order that it was removed.

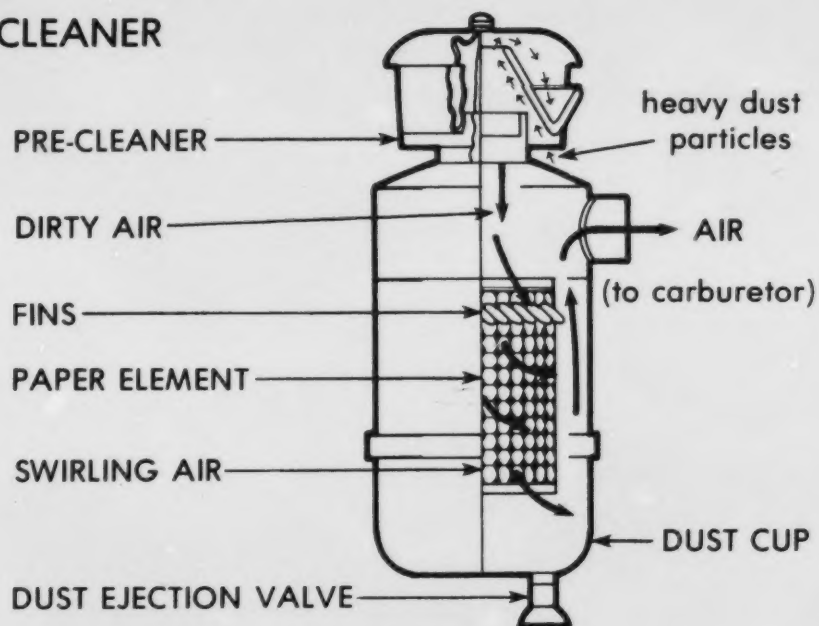
This type of air cleaner requires frequent attention. Although it may not be checked daily, it should be checked more frequently than the dry type air cleaner, when operating under similar conditions.

References:

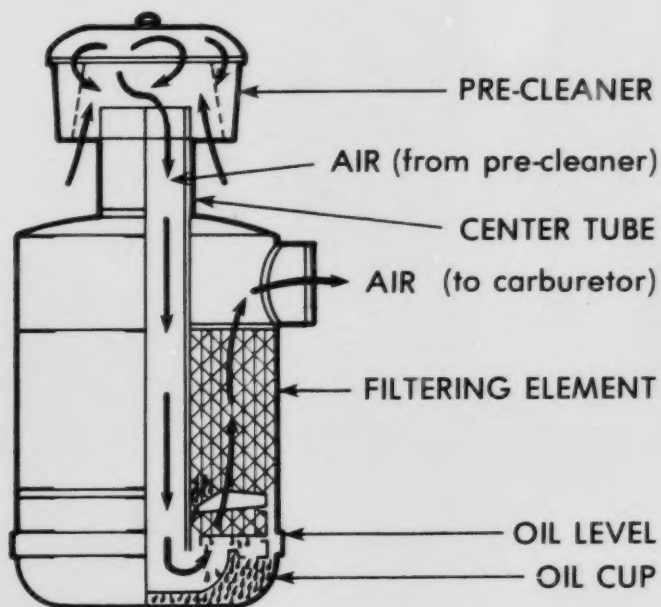
1. "Farm Tractors - Basic Principles, Operation and Maintenance", Engineering Bulletin FT-53, American Oil Co., Chicago, IL.
2. "Fundamentals of Service Engines:", Deere and Co., Moline, IL.
3. "Gulf Farm Tractor Guide", Gulf Oil Corp., Houston, TX.
4. Promersberger, William J. and others, Modern Farm Power, Prentice-Hall, Inc., Englewood Cliffs, NJ.
5. "Tractor Maintenance - Principles and Procedures", AAVIM, Athens, GA.
6. "FMO Preventive Maintenance", Deere & Co., Moline, IL.

TYPES OF AIR CLEANERS

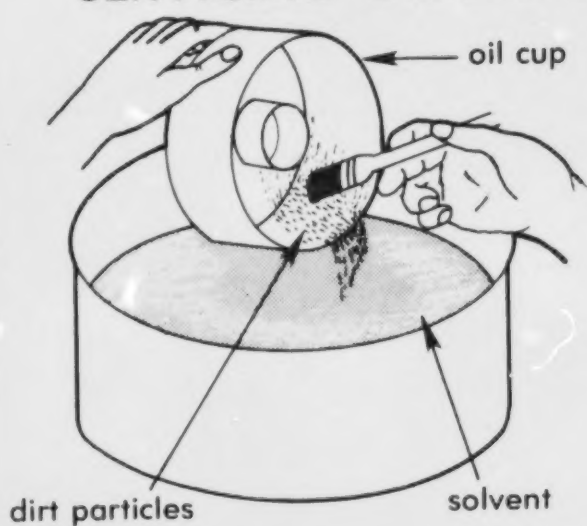
DRY-TYPE CLEANER



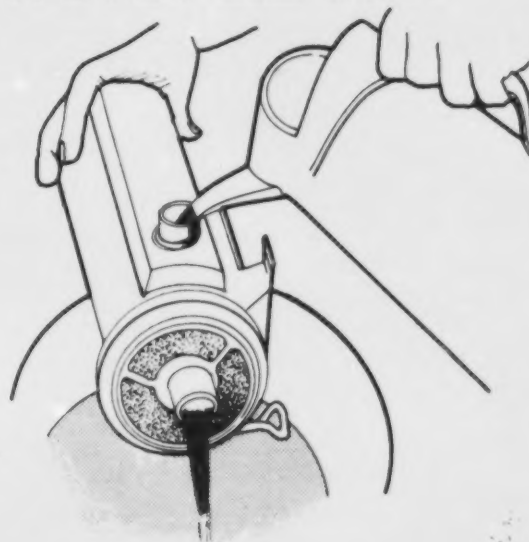
OIL BATH



SERVICING OIL-BATH TYPE AIR CLEANER

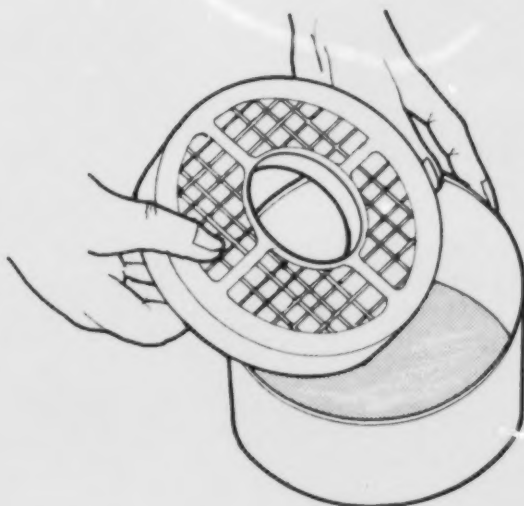


Cleaning Cup

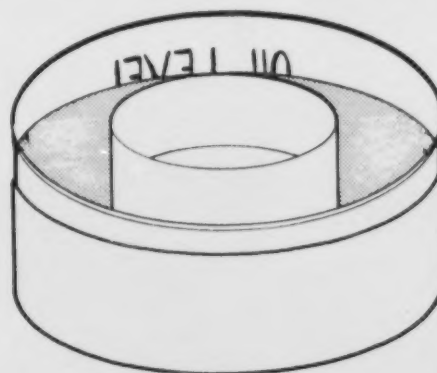


Flushing Element

CLEANING OIL-BATH CLEANER PARTS

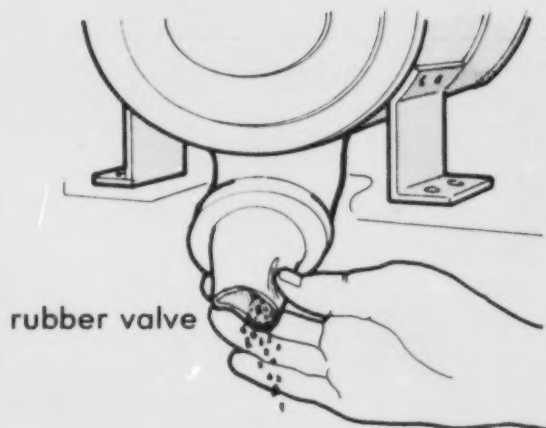


REMOVING FOREIGN MATERIAL
FROM SCREEN



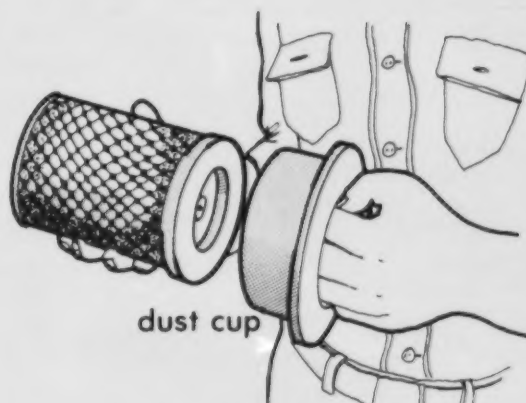
REFILLING OIL CUP TO OIL LINE

DRY TYPE AIR CLEANER



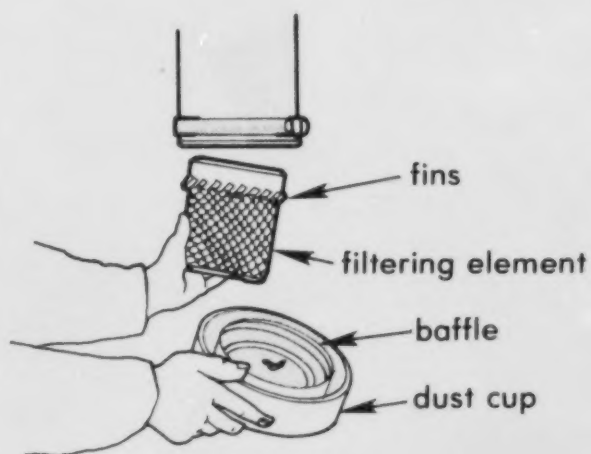
rubber valve

DUST UNLOADER
(rubber valve type)

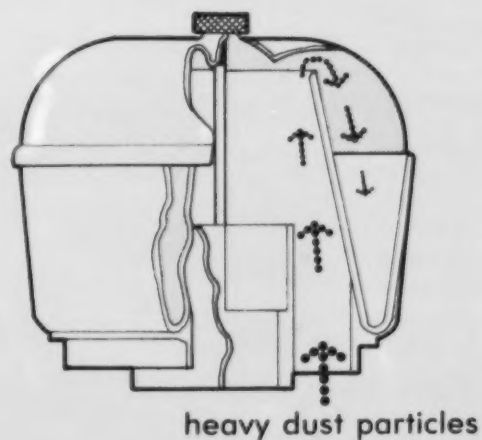


dust cup

REMOVING DUST CUP



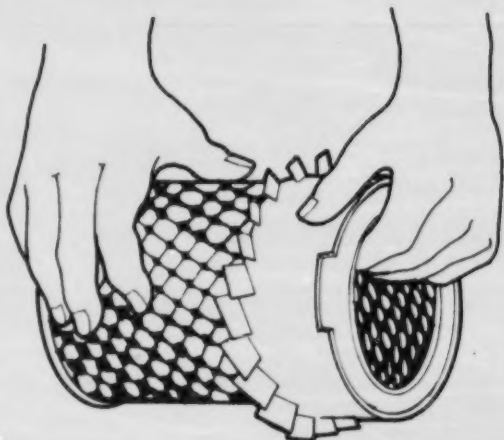
REMOVING FILTERING ELEMENT



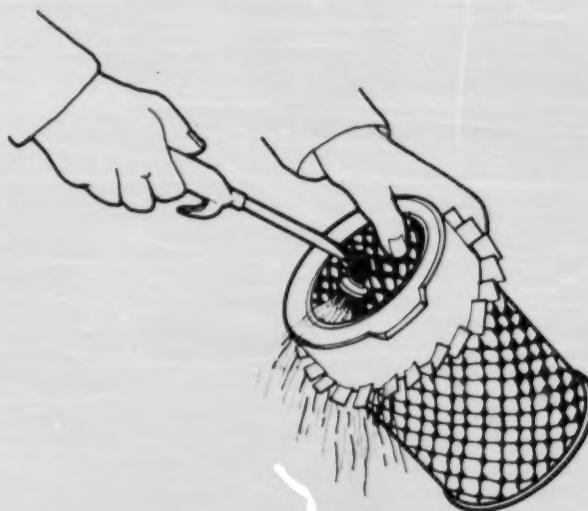
heavy dust particles

PRE-CLEANER

CLEANING THE DRY ELEMENT



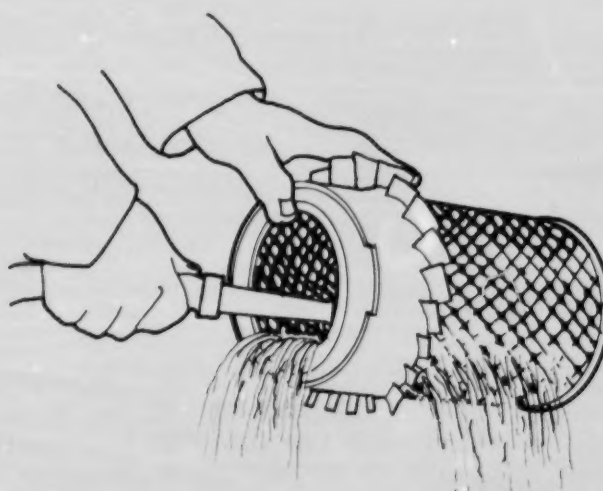
TAP ELEMENT TO LOOSEN DIRT



USE AIR TO REMOVE DIRT

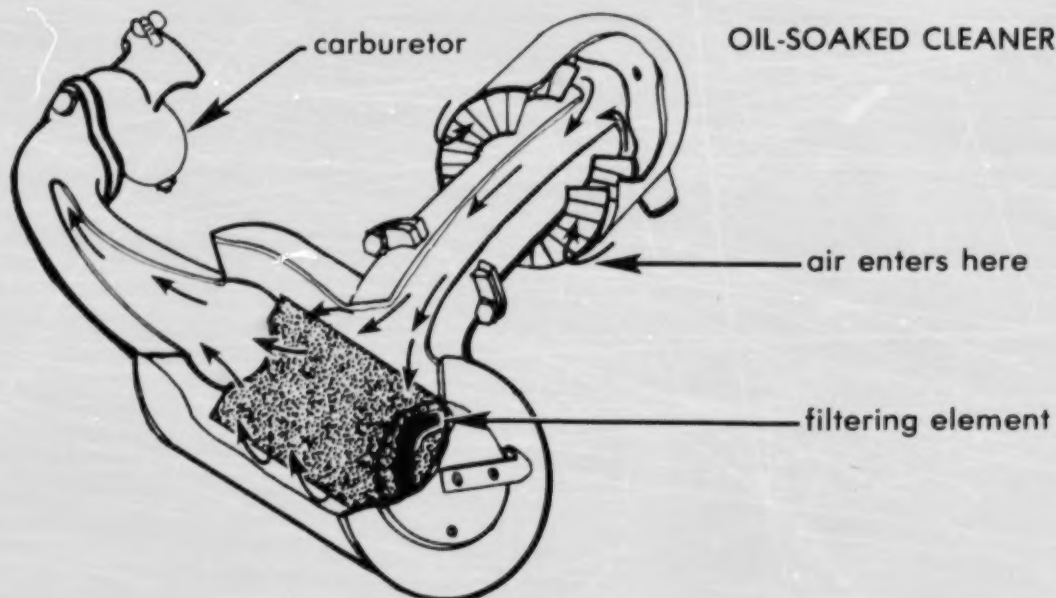


WASH ELEMENT IN SOAPY WATER

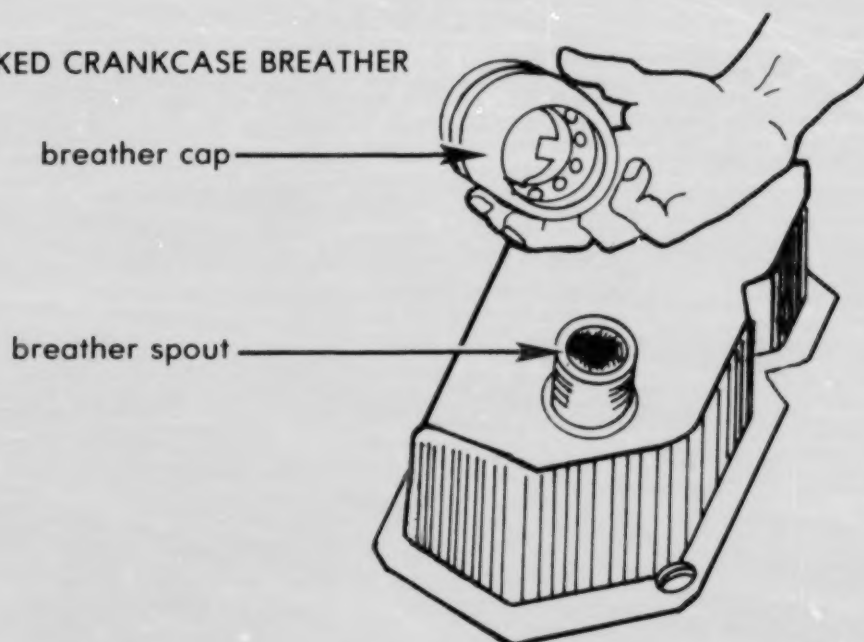


RINSE ELEMENT WITH CLEAN WATER

SERVICING OIL-SOAKED CLEANER & BREATHER



OIL-SOAKED CRANKCASE BREATHER



AGRICULTURAL MECHANICS

UNIT C: Tractor Maintenance

TOPIC 4: Checking Crankcase and Lubricating

Suggested Procedures and Activities: During the class discussion the use of transparencies may be helpful in explaining the classification of oils and oil grades, types of lubricating systems, and the proper method of changing the crankcase oil. An exhibit of the different types of oils and greases may be used as teaching aids.

1. The Purpose of Lubricating a Tractor

The five major purposes for lubricating tractors are:

- a. To lubricate moving parts. Oil and grease reduces friction to a minimum, by supplying a layer of oil between the moving parts. A proper layer of oil will actually separate wearing parts.
- b. To assist in cooling moving parts. The pistons, wrist pins, and main and connecting rod bearings depend upon the circulation of oil as a cooling agent. Oil removes heat from the moving parts of an engine and transfers it to cooler oil and metal surfaces. These surfaces transfer the heat outside the engine.
- c. To act as a seal. Oil prevents the combustion gases from leaking past the piston rings which aids in the elimination of power loss. The seal may function as a cushion when metal parts are in contact with each other under great amounts of pressure. For example, on the power stroke of an engine, the oil film prevents metal-to-metal contact by absorbing the force created by the stroke.
- d. To keep the moving parts clean. Soots and other contaminants are carried away in the oil to a filter where they are picked up and held. Other contaminants are held in suspension in the oil and eliminated when the crankcase is drained. In keeping the engine clean, oil acts as a carrier for corrosion and rust additives that are provided for these purposes.
- e. To eliminate power loss caused by friction. Friction between metal moving parts is reduced if enough oil is present to provide viscous friction (friction between the molecules of oil).

Transparency No. 1

2. Classification and Grades of Oil and Types of Grease

The classification and grades of oil are based upon the oil properties. One of the most important properties is the body of the oil (viscosity). Oil's viscosity is determined by its ability to flow through a standard size opening at a given temperature.

- a. The SAE (Society of Automotive Engineers) Viscosity Classification System was adopted in 1926, to recommend motor oils to meet temperature requirements, design, and service affecting viscosity. Such properties as color and additives are not covered by this system.

Oils are classified into grades which are based upon the viscosity tests. SAE crankcase oils are classified in the following manner:

SAE Viscosity Numbers

SINGLE VISCOSITY

5W

10W

20W

20

30

40

50

MULTI-VISCOSITY

5W - 20

10W - 30

20W - 40

Multi-viscosity oils do not become thin when they are heated. These oils also have the ability to resist thickening in low temperatures. However, all oils thicken to a degree when the temperature decreases. Oils thin when the temperature increases. Multi-viscosity oils are also used in LP-Gas and diesel engines.

- b. The API (American Petroleum Institute) system of classifying lubricating oil was developed on the basis of engine requirements under certain types of working conditions.

The API service classifications of oils for gasoline and diesel engines are:

Summary of Current Equipment Manufacturer Recommendations

<u>Application</u>	<u>API Performance Classification</u>	<u>Current Common Name</u>
Gasoline Engine Passenger Car	SE	MIL-B
Gasoline Engine Truck	SE or CC	MIL-B
Diesel Engine Truck or Tractor	CB, CC, or CD	Supplement - 1 MIL-B Series 3 (S-3)

- c. Greases have two main ingredients, oil and soap-type thickening agencies. Greases range from very soft to very hard consistencies. The three most common types of soap thickener used in grease are:

Lime Soap Greases - These greases are used in a pressuregun to grease the chassis. They are not recommended on parts where the temperature exceeds 190° F. Lime soap greases are resistant to water.

Soda Soap Greases - These greases are made to withstand high temperatures, but they are not resistant to water. Soda soap greases are used on wheel and/or ball bearings.

Lithium Soap Greases - These greases are used extensively for greasing tractors. They are resistant to both heat and water, thus they are considered multi-purpose greases. Some lithium soap greases contain additives with rust protection and pressure properties.

Transparencies Nos. 2 and 3

3. Types of Engine Lubricating Systems

The oil carried in the crankcase of a tractor engine lubricates the following parts by circulating and splashing the oil:

Main bearings and connecting rod bearings.

Cylinder walls, piston rings, piston pins, and pistons.

Camshaft bearings, cams, valve lifters, and valve guides.

Governor in most common tractors and the injection pump in some diesel tractors.

The common types of lubrication systems are:

- a. Splash - This system was used on the earlier tractors. Oil was splashed to the working parts in the engine by cups, dippers, or troughs in the engine. This lubrication system is still used on one-cylinder engines.
- b. Circulating-Splash - Oil is splashed to parts of the engine by the end of connecting rods as they revolve through the splash pan troughs. Oil is supplied to the troughs by an oil pump located in the crankcase. An oil mist caused by the ends of the connecting rods passing through the troughs lubricates the cylinder, piston assembly, and many other moving parts. Some channeling and piping to lubricate the bearings are found in the circulating-splash system.
- c. Force-Feed - This system may be identified as a modified circulating-splash system, unless it is complete force feed. An oil pump picks up oil and forces it to the various parts of the engine. Oil passes from the main line to the main bearings, oil filter and oil gauge.

The secondary line lubricates the cam, idler gear, and timing gear. The third line, if present, lubricates the valve system. The connecting rods do not dip into troughs in this lubricating system. The relief valve maintains approximately 15 pounds of pressure, thus the oil is forced to most moving parts by pressure.

Transparency No. 4

The two types of pumps most commonly used are:

The external or gear pump is found on most tractors. It is driven by the camshaft.

The rotor or vane pump is usually driven by the crankshaft; therefore, it is found inside the engine.

Usually, if an oil pump is functioning properly, the oil pressure will show a normal reading. However, the reading may be normal when the oil is failing to circulate, if the engine is idling too slow.

4. Changing the Crankcase Oil

Lubricating oils wear out. They lose their lubricating qualities when the additives become depleted and the oil becomes dirty. Oils are contaminated with sludge, varnish, acid formations, fuel soot, and gasoline.

Oil is changed regularly and frequently to insure long engine life. A tractor starts and stops often, causing it to burn more oil than vehicles which travel long distances without stopping and starting frequently.

Crankcase oil should be drained while the oil is warm, so it is important to remove the oil immediately after stopping the tractor. More of the dirt, sludge, and other contaminants may be removed if they have not had a chance to settle out.

If the tractor is stored, new oil should be added at the beginning of the storage period. Fresh oil will eliminate sludge and dirt settling out in the crankcase.

During the winter (cold) months water will accumulate in the crankcase if the tractor is not allowed to run until a normal temperature is reached. Watery oil should be changed.

Most modern tractors are equipped with ventilation systems which dispose of the unburned fuels and water in the crankcase. The ventilation system reduces the formation of certain contaminants. This system takes air into the engine through the breather cap.

Factors that may influence the changing of engine oil are:

- a. Length of running period between oil change.
- b. Color of the oil. The oil may be dark and still have body and film-forming ability.

- c. Oil contains water, sludge, and other contaminants.
- d. Long idle periods for the tractor.
- e. Running the tractor on many short trips during cold months.
- f. Using tractor on dusty or dirty types of jobs.
- g. Metal and other abrasive material collected in the crankcase.

Transparency No. 5

Crankcase oil is changed by removing the oil drain plug from the oil pan. The plug is replaced after the hot oil is completely removed. Follow the recommendations of the manufacturer regarding the type of oil to use.

Transparencies Nos. 6 and 7

5. Changing the Oil Filter

- a. The purpose of the oil filter is to remove the impurities from the oil such as abrasive and other foreign materials. Most tractors are equipped with oil filters.
- b. The two most common types of filters found on tractors are the surface and depth.

Surface Filters - These filters strain the particles of dirt as the oil passes through a straight line path through the holes. The holes are smaller than the dirt particles; therefore, as the particles hit the surface they fall into the filter reservoir. These filters are made of either wire mesh, stacked metal, or paper disks.

Depth Filters - The depth filters are absorbent or adsorbent. The absorbent filters will trap porous materials, soak up water, and soak up impurities. The cotton, wood, wool, or paper material reacts like a sponge that takes in water. The adsorbent filters are chemically treated so they attract and remove impurities.

- c. Servicing most filter systems is accomplished by replacing the removable cartridge. Some makes of tractors have filter elements contained in a removable housing. The housing and mounting base in this type of filter should be cleaned with a solvent and dried with compressed air. If the relief valve is removable it should be cleaned and dried.

Metal filters (edge-type) should be soaked about a day in lye water if the filter has a varnish-like substance on it. In most cases a metal filter can be cleaned with solvent and a brush.

When servicing a filter, new gaskets and rings should be used. It is usually recommended that the filter be changed at the same time the crankcase oil is changed. The engine should be allowed to run until adequate oil pressure registers on the gauge, then checked for leaks.

6. Lubrication of Tractor Transmission and PTO Drives

Transparency No. 8

Transmission care is equally as important as lubricating other parts of the tractor. The lubricant in the gear case is splashed, pumped, or splashed and pumped to all working parts.

Gear lubricants undergo the same changes as engine lubricants. Oxidation and thickening may take place and the additives may become depleted.

The contaminants found in a transmission are: fine dust, moisture, and metal particles.

Transmission lubricant should be changed only when the oil is warm. If the transmission is to be flushed after it is drained, kerosene or diesel oil should be used. Flushing is accomplished by filling the gear case with the thin lubricant and then driving the tractor for several minutes before draining and refilling with a new lubricant. Some transmissions have more than one drain plug. The operator's manual explains the type of lubricant that should be used.

7. Important Things to Remember About Greasing the Tractor

The operator's manual is used to determine when and how to lubricate (grease) the tractor. Tractors that work under moist or dusty conditions need lubricating more frequently than tractors working in ideal conditions.

It is very important to use the right type and right amount of grease. Some working parts (steering system) are enclosed in a rubber container that may be damaged if too much grease is added at one time.

All grease fittings must be wiped clean before applying grease with the grease gun. Grease must be free of impurities. Abrasive dust particles can destroy a bearing in a very short time.

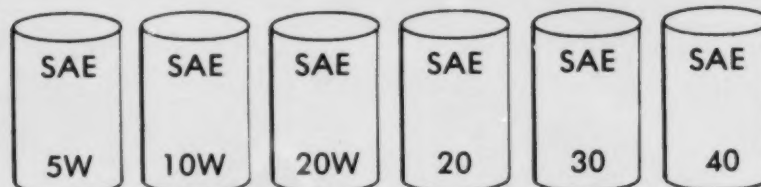
References:

1. "Farm Tractors - Basic Principles, Operation and Maintenance", Engineering Bulletin, FT-53, American Oil Co., Chicago, IL.
2. "Fundamentals of Service Engines", Deere and Co., Moline, IL.
3. Phipps, Lloyd J., Mechanics in Agriculture, The Interstate Printers and Publishers, Inc., Danville, IL.
4. Promersberger, William J. and others, Modern Farm Power, Prentice-Hall, Inc., Englewood Cliffs, NJ.
5. "FMO Preventive Maintenance", Deere & Co., Moline, IL.

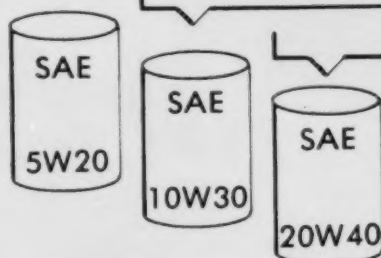
CLASSIFICATION OF OILS

SAE VISCOSITY NUMBERS

SINGLE VISCOSITY



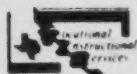
MULTI-VISCOSITY



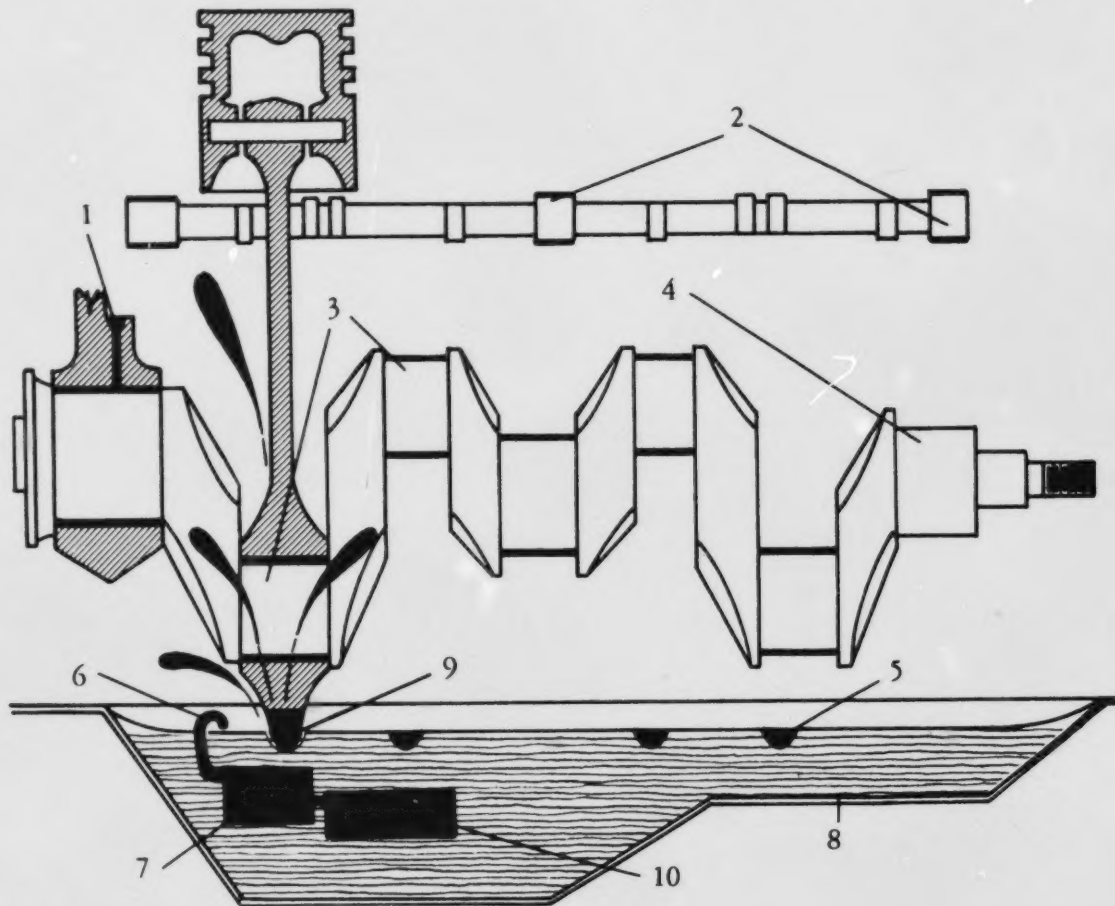
API CLASSIFICATION

SUMMARY OF CURRENT EQUIPMENT MANUFACTURER RECOMMENDATIONS

APPLICATION	API PERFORMANCE CLASSIFICATION	CURRENT COMMON NAME
Gasoline Engine passenger car	SE	MIL-B
Gasoline Engine truck or tractor	SE or CC	MIL-B
Diesel Engine truck or tractor	CB, CC, or CD	Supplement - 1 MIL-B Series 3 (S-3)



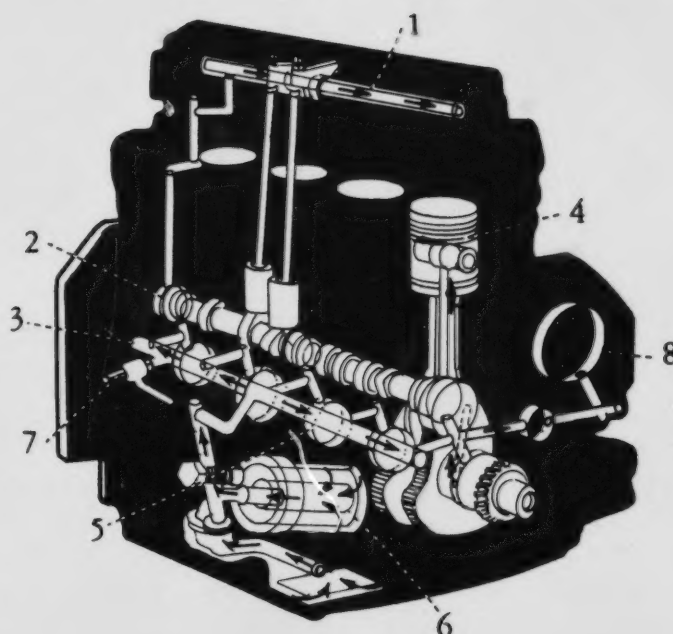
LUBRICATION SYSTEM



CIRCULATORY SPLASH

- | | |
|----------------------|---------------------------|
| 1. OIL TROUGH | 6. SPLASH PAN SUPPLY TUBE |
| 2. CAMSHAFT BEARINGS | 7. OIL PUMP |
| 3. ROD BEARINGS | 8. OIL PAN |
| 4. MAIN BEARINGS | 9. OIL DIPPER |
| 5. SPLASH TROUGHS | 10. OIL STRAINER |

LUBRICATING SYSTEM

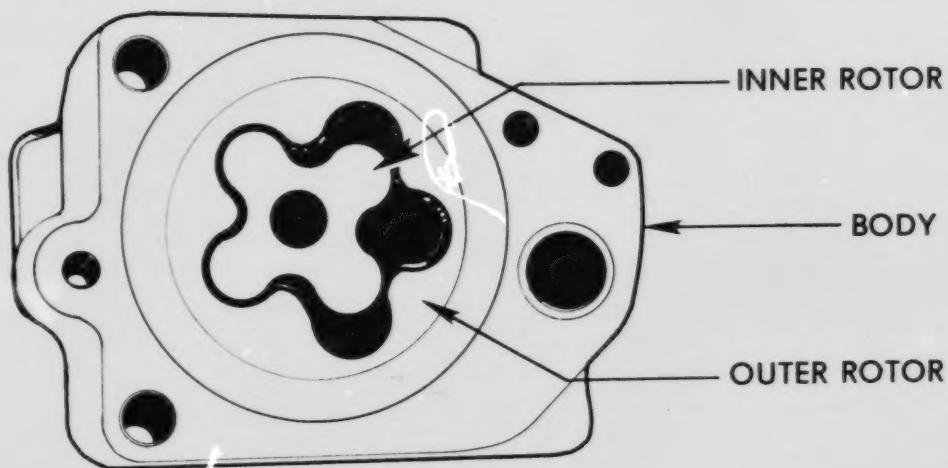


FORCE FEED

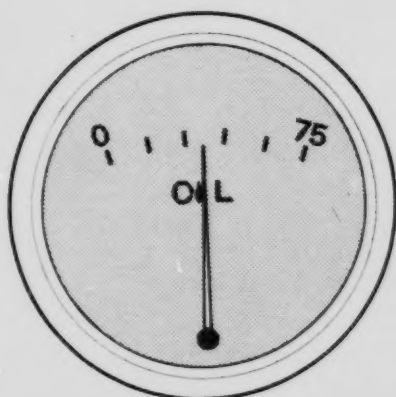
1. TAPPET SHAFT
2. CAMSHAFT BEARINGS
3. MAIN OIL GALLERY
4. PISTON PIN BEARINGS
5. MAIN BEARINGS
6. OIL PUMP AND FILTER ASSEMBLIES
7. OIL PRESSURE SCREW
8. VENTILATOR PUMP

OIL PUMPS AND PRESSURE GAUGE

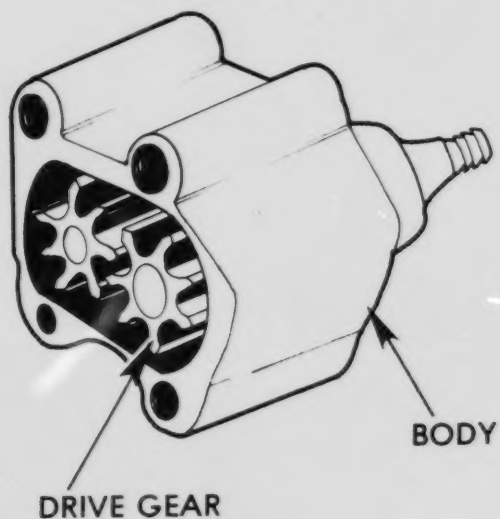
ROTOR PUMP



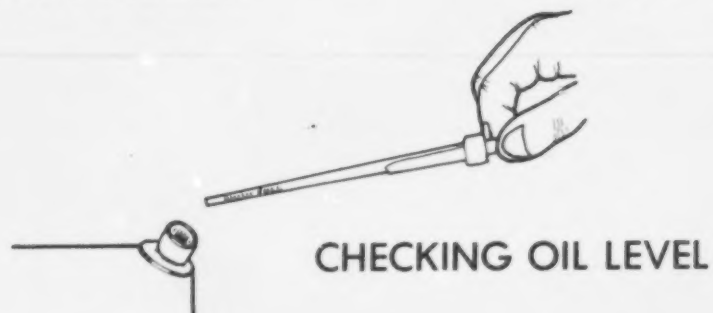
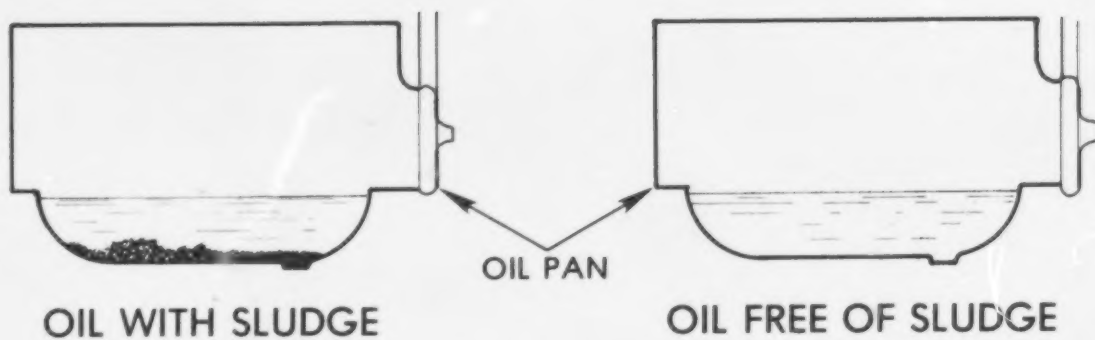
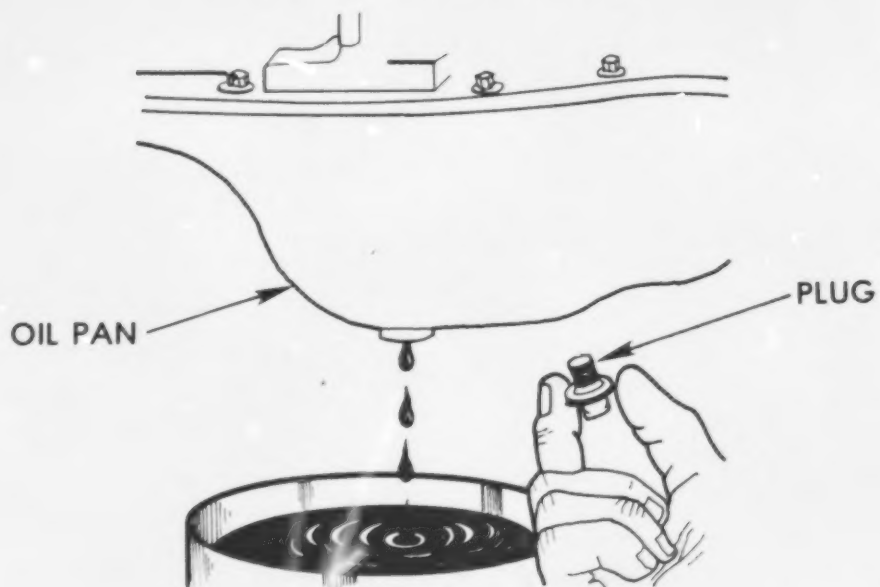
PRESSURE GAUGE



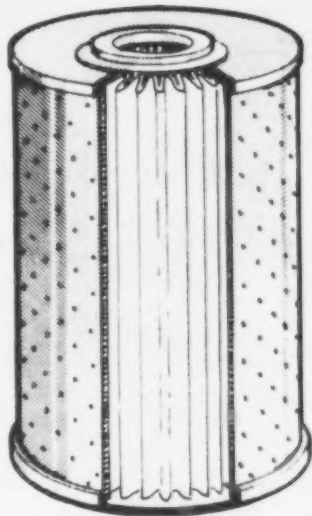
EXTERNAL PUMP



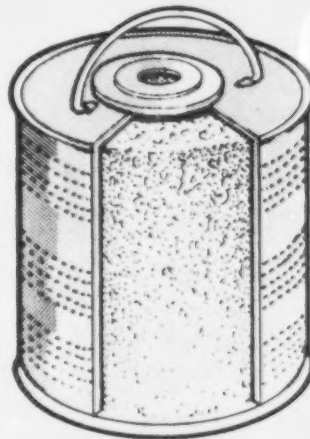
DRAINING THE OIL



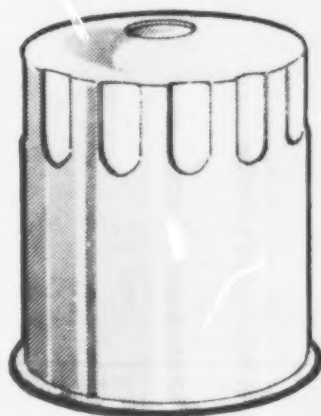
TYPES OF OIL FILTERS



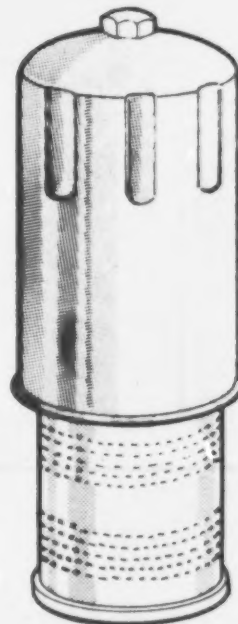
SURFACE FILTER



DEPTH FILTER

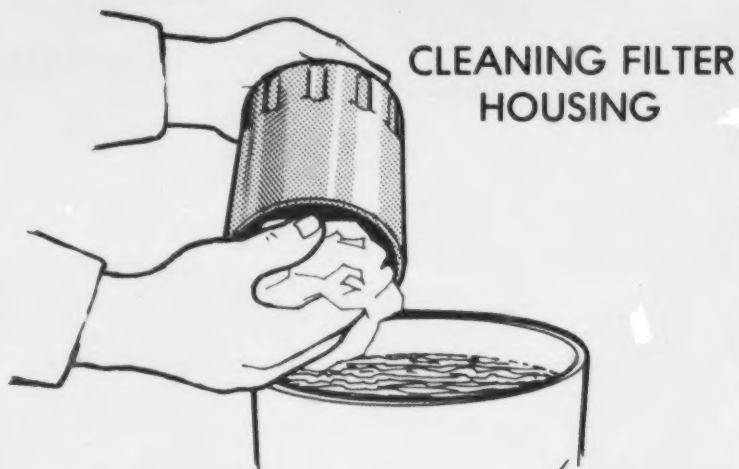


DISPOSABLE FILTER

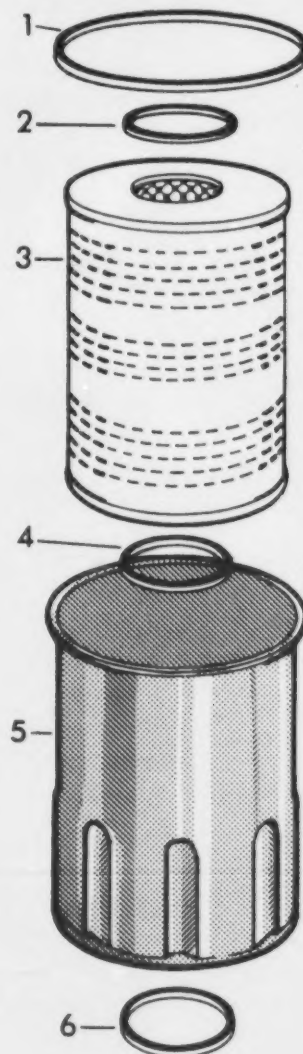
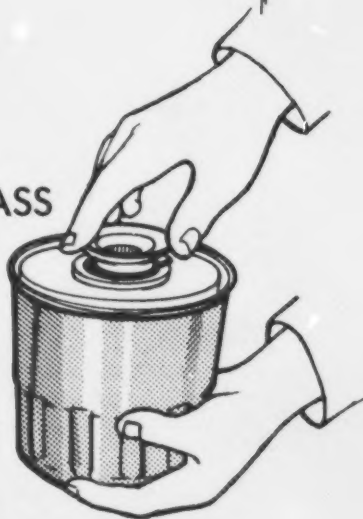


DISPOSABLE ELEMENT

SERVICING OIL FILTER



REPLACING BYPASS
ELEMENT



1. HOUSING GASKET

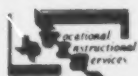
4. GASKET

2. GASKET

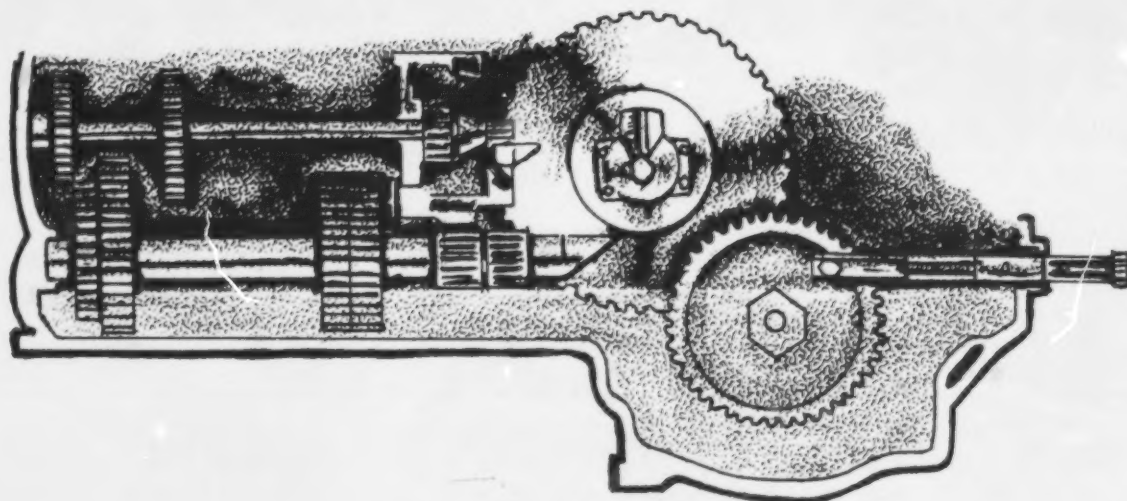
5. FILTER HOUSING

3. FILTER ELEMENT

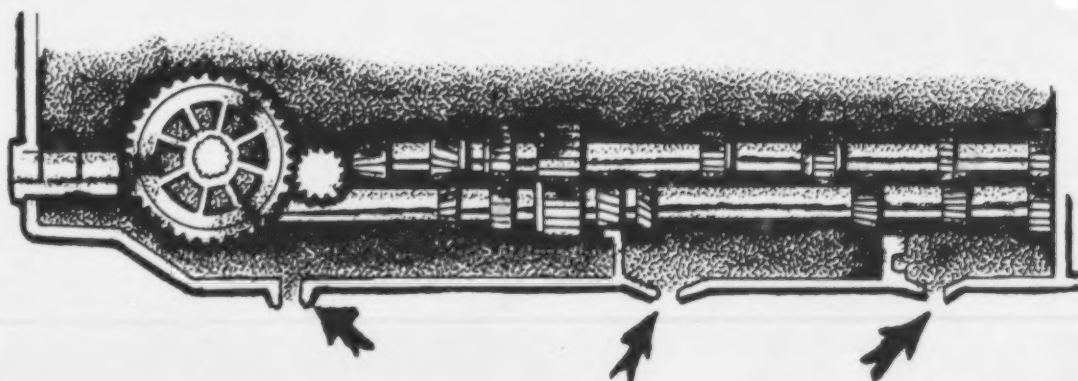
6. GASKET



LUBRICATION OF TRANSMISSION



LUBRICATION LEVEL ON SINGLE COMPARTMENT
TYPE TRACTOR



THREE COMPARTMENTS FOR LUBRICATION OF
TRANSMISSIONS AND PTO DRIVE

AGRICULTURAL MECHANICS

UNIT D: Farm Water Supply and Sanitation

TOPIC 1: Skills Needed to Install Pipe and Plumbing Fixtures

1. Maintaining the Farm Water Supply

In order to avoid delays, save money, and maintain a constant supply of water to farm buildings and for livestock, the farmer should be able to make minor repairs to a water system. If a farmer has an extensive water system or several systems on the farm, it may be wise to obtain the necessary tools and to perform the major repairs on the water system.

Repairing Faucets and Valves

Repairs to faucets and valves are possibly the maintenance jobs most often performed by the farmer. Faucets are used at water discharge points, while valves are used to close off a part of the plumbing system. Faucets and valves are very similar, and the instructions for repairing them are the same. There are several kinds of each, but all are repaired in about the same manner.

Transparency No. 1

Mixing faucets, found on sinks, bathtubs, and showers are actually two separate units. Each unit should be repaired independently. If a faucet drips when closed, or vibrates ("sings" or "flutters") when open, it usually has a worn washer. If it leaks around the spindle when open, new packing is needed around the stem.

The following procedure may be used to replace the washer:

- a. The water is shut off at the valve nearest to the faucet.
- b. The faucet is disassembled in the following order:
 1. Handle
 2. Packing nut
 3. Packing
 4. Spindle
- c. The screw and worn washer are removed from the spindle. A new washer is installed in the cup.
- d. The seat should be examined. If it is rough, it should be refaced with a seat-dressing tool, which may be purchased from a hardware store.
- e. The faucet is reassembled. To replace the packing, one should remove the handle, packing nut, and add packing, and install a new packing washer. If a packing washer is not available, stranded graphite-asbestos wicking may be wrapped around the spindle. The packing nut is screwed tight against the wicking.

Repairing Leaks in Pipes - Leaky pipes are usually caused by corrosion or damage from freezing, machinery, or animals. Generally when corrosion exists, it is in varying degrees for the entire length of the pipe; however, an exception to this occurs where different kinds of metal are joined,

such as copper and steel. There is a tendency for different kinds of metal to corrode much faster where they are joined. It is possible at times to prevent corrosion by testing the water and taking the proper precautionary measures if they are needed. The method used to repair a leaky pipe is determined by the area in which the pipe leaks and the size of the leak. Leaks may be repaired as follows:

- a. Small pipe leaks - Emergency repairs can be made with a rubber patch, metal clamp, or sleeve. However, the pipe should be replaced as soon as practicable.
- b. A leak at a threaded connection - This type of leak can often be stopped by unscrewing the fitting and applying a pipe joint compound. The compound, available from most plumbing supply firms, seals the joint when the fitting is screwed back together.
- c. Large leaks in a pipe - There are several ways of repairing this type of leak. The old pipe can be removed and plastic pipe put in its place. (Clamps are used to hold the pipe in place). This type of repair should not be used in the farm household. If the leak is near a joint, the damaged pipe may be cut out and a new pipe installed with the use of a union.
- d. Leaks at solder joints - Due to vibration or some other reason, solder joints sometimes start leaking. These may be resoldered if they are accessible.

Repairing Leaks in Storage Tanks - Most farms have several tanks for storing water or other liquids. The life of these tanks may be prolonged by repairing the leaks. One method of repairing a leak in a tank is to use a rubber washer, brass washer, and toggle bolt. It may be necessary to drill the hole larger in the tank to insert the toggle bolt. The rubber washer, brass washer, and nut are placed on the toggle bolt in the order given. The toggle bolt is pushed through the hole, and the nut is tightened until the rubber washer is compressed against the tank. This repair will postpone buying a new one, but the tank will eventually have to be replaced.

2. Repairing Water Closets

There is some variation in the design of flush toilets, but they are enough alike that one should be able to repair them by following these instructions.

Transparency No. 2

The flush valve, intake (float) valve, and float ball are generally the parts on a water closet that need repairing. Instructions for repairing each are given.

Repairing the Flush Valve - A leaky flush valve is usually caused by the decomposition of the rubber ball. It gets soft and fails to seat properly. Other parts that may cause the flush valve to leak are the trip lever, connecting rod, or lift wire. If they cannot be repaired, they should be replaced.

To replace the rubber ball, stop the flow of water by tying the float or propping it up with a piece of wood. The lift wire is screwed out of the old rubber ball and screwed into the new one. This can be accomplished without removing the tank ball guide from the overflow pipe.

Repairing the Intake Valve - A worn plunger washer in the supply valve will cause this valve to leak. If the washer is not causing the leak, the float-

valve assembly should be replaced. The procedure for replacing the washer is as follows:

- a. The water is shut off, and the tank is drained.
- b. The two thumbscrews that hold the levers are unscrewed, and the levers are pushed out.
- c. The plunger is lifted out, and the cup on the bottom is unscrewed. A new washer is inserted.
- d. The washer seat should be refaced if needed.

If the float ball is leaking or fails to rise to the proper position (correct water level is about one inch below the top of the overflow tube), the ball should be repaired or replaced.

Water Closet Bowl Removal - If the water closet bowl leaks, it may be necessary to remove it to repair the leak. The procedure is as follows:

- a. The water is shut off.
- b. The tank and bowl are emptied.
- c. The water pipes are disconnected from the tank.
- d. If it is a two-piece unit, the water bowl is disconnected from the tank.
- e. The seat and cover are removed.
- f. The bolt covers are removed, and the bolt holding the bowl to the floor flange is removed.
- g. The bowl is repaired.
- h. The tank is installed, and the water pipes are connected.
- i. The bowl is checked for leaks by flushing a few times.
- j. The seat and cover are installed.

3. Clearing Clogged Drains and Traps

Transparency No. 3

Drains become clogged by objects falling into them or by an accumulation of dirt and other matter, and they should be cleaned periodically rather than waiting until they are clogged. Periodical cleanings are much easier.

If a fixture trap is clogged, usually the trap must be removed and cleaned to unstop the drain. If a drain pipe is clogged, there are several methods that may be used to unclog the drain:

- a. A plunger, often called a plumber's friend, can be used successfully sometimes to unclog drains.
- b. Cleanout Augers - Flexible cables are often used to clear obstructions in drain pipes. Some plumbers have power driven augers, and it may be necessary to secure their services if the drain is closed by root growth. If it becomes necessary to use a root saw, the drain should be eventually replaced.

Water pressure from a hose may break up an obstruction or force an object through the pipe. If this method is used, the hose should be inserted well into the pipe, and rags should be wrapped around the hose where it enters the pipe to minimize a backward flow of water.

Chemical cleaners are an effective means of loosening grease and soap from pipes; however, they should not be used in pipes that are completely stopped up. They must be brought in direct contact with the stoppage

to be effective. After chemicals are used, the pipe should be flushed with cold water.

4. Maintaining Water Pumps

The two most common water systems found on farms are the gravity flow system and the pressure system. Each system is discussed separately.

Gravity Flow System - If the gravity system is used, a pump and storage facility must be maintained to provide an adequate water supply. The maintenance problems usually connected with a gravity flow system are the repairing of leaks and the maintaining of an adequate flow of water. Observing the daily water consumption on the farm will assist the farmer in detecting leaks. If an abnormally large amount of water is used during a short period, or if there has been a considerable increase in water consumption without an apparent reason for the increase, there is a possibility that the system is leaking. Underground leaks are difficult to detect. If after walking along the routes of the underground pipes, the farmer has not detected a leak, indicated by a wet or damp spot, he should turn off a part of his water system to determine the area of greatest consumption. If the area of the leak can be determined, all connections should be checked for leaks. If the leak is still undetected, it may be necessary to dig up some of the pipe.

Since the maintenance problems of wells and pumps are similar, regardless of the kind of water system, pump and well maintenance is discussed under the pressure system.

Transparency No. 4

Pressure System - Troubles with a pressure system are more difficult to determine because of the automatic controls and safety devices.

The following list of possible problems shows what one might encounter in maintaining a well and pressure system and the areas that should be checked to eliminate the problem:

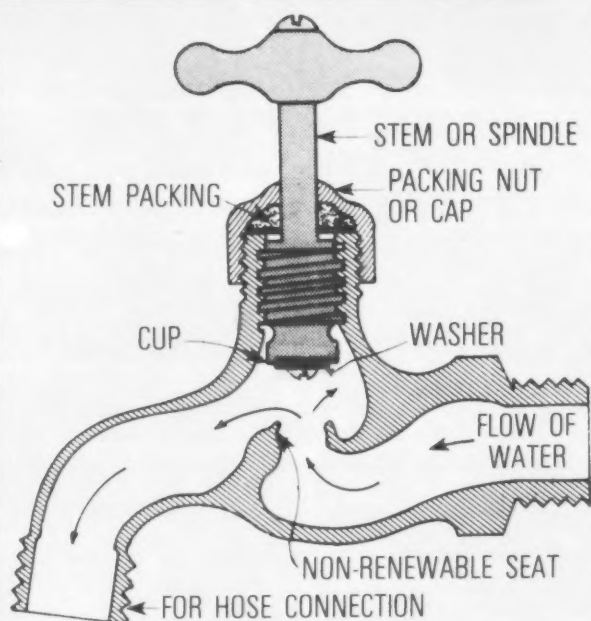
- a. The Pump Fails to Deliver Water
 1. Air leak in suction pipe
 2. Water level below the end of the suction pipe
 3. Pump lost prime
 4. Stuck foot valve
 5. Plugged suction
 6. Dry well
 7. Plugged jet
 8. Cracked cylinder
 9. Worn leathers (reciprocating pump)
 10. Worn valve on jet pump
 11. Broken plunger rod
- b. Pump Fails to Deliver a Normal Amount of Water
 1. Pipe valve leaking
 2. Cracked cylinder
 3. Air in suction pipe
 4. Belt to motor is too loose
 5. Low voltage
 6. Suction pipe too small
 7. Improper setting on pressure regulator

- c. Pump Stops and Starts Often
 - 1. Not enough air in pressure tank
 - 2. Leaky foot valve
 - 3. Leak in plumbing
 - 4. Tank too small
 - 5. Air pump out of order
- d. Air Spurts from faucets
 - 1. Too much air in tank
- e. Pump Motor Fails to Run
 - 1. Power off
 - 2. Broken power line
 - 3. Blown fuse
 - 4. Circuit breaker open
 - 5. Burned motor
 - 6. Reset fuse blown
 - 7. Malfunctioning motor switch

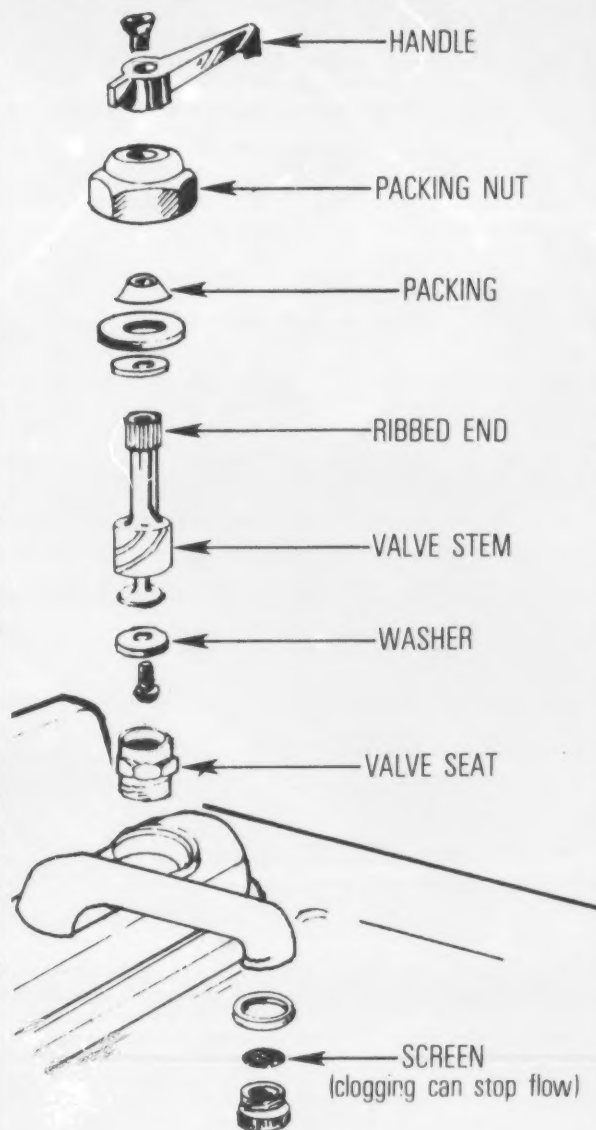
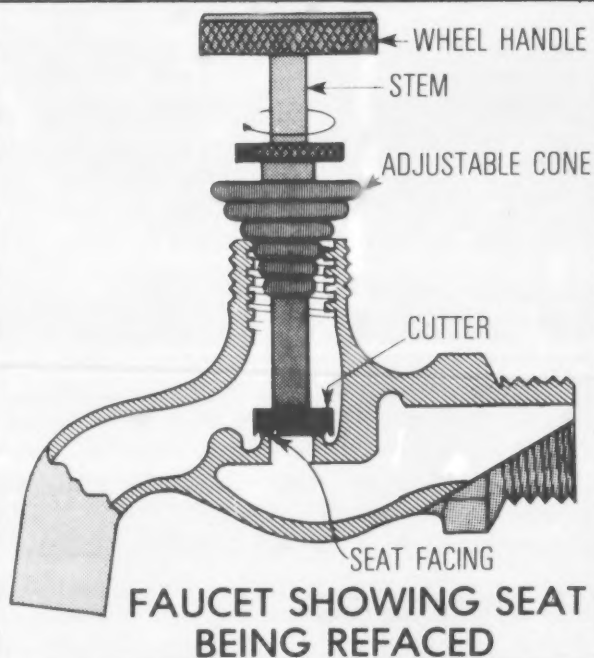
References:

- 1. Phipps, Lloyd J., Mechanics in Agriculture, The Interstate Printers and Publishers, Inc., Danville, Illinois.
- 2. Wakeman, T. J., Modern Agricultural Mechanics, The Interstate Printers and Publishers, Inc., Danville, Illinois.
- 3. Wright, Forrest B., Rural Water Supply and Sanitation, John Wiley and Sons, Inc., New York, New York.
- 4. Sears, Roebuck and Co., "Plumbing Handbook", Chicago, Illinois.

PARTS OF FAUCETS

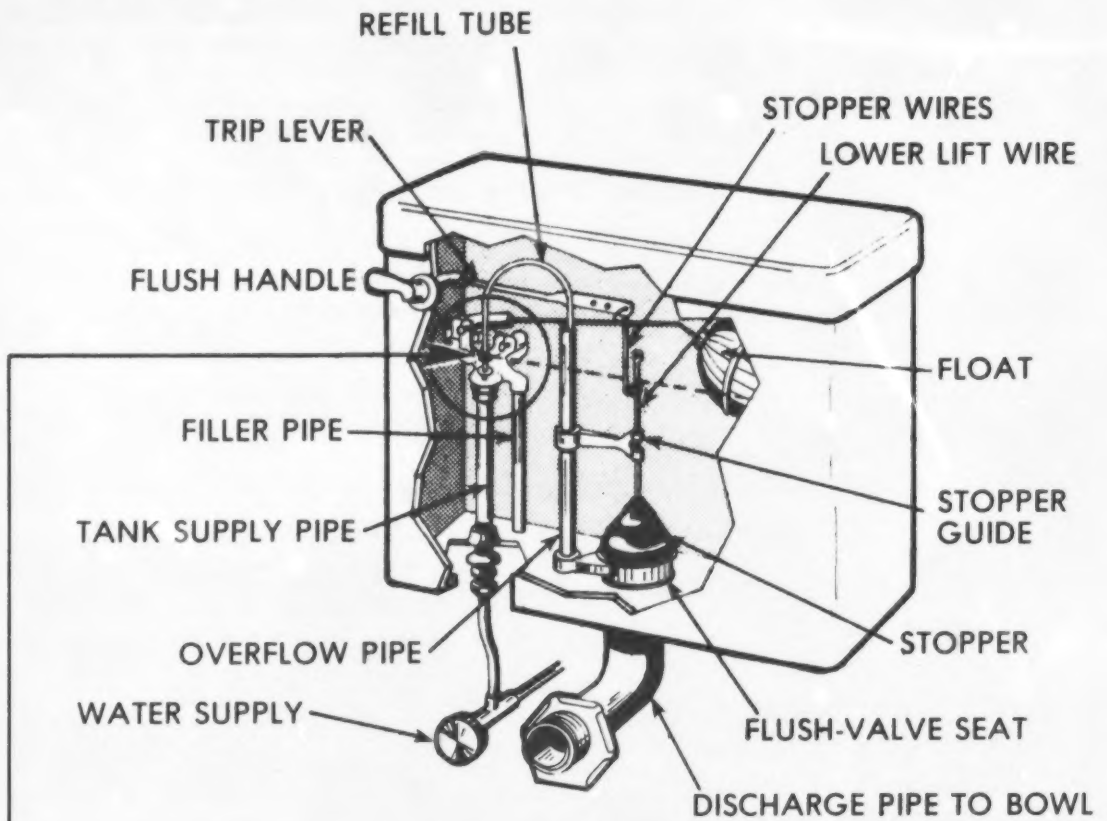


SINGLE COMPRESSION FAUCET

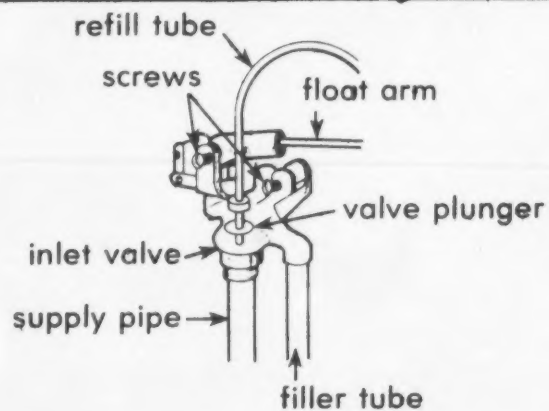


MIXING FAUCET

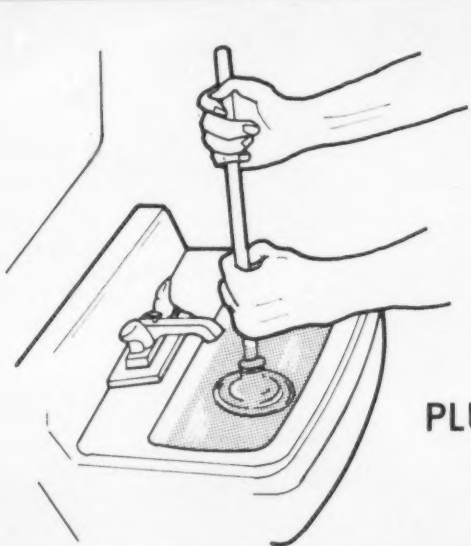
A WATER CLOSET



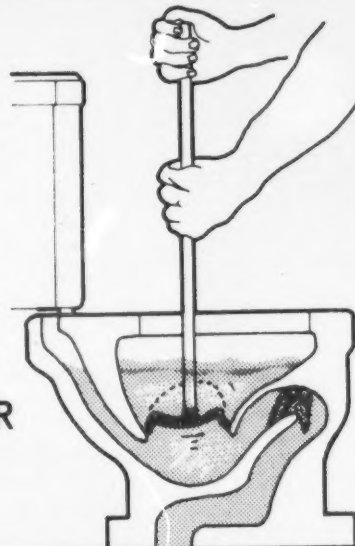
BALL COCK



CLEANING CLOGGED DRAINS AND TRAPS



PLUNGER



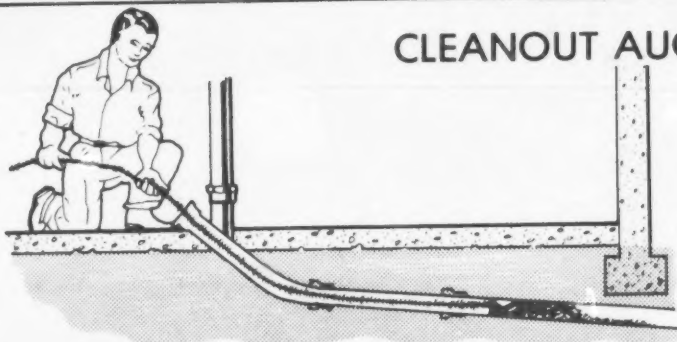
CHEMICAL



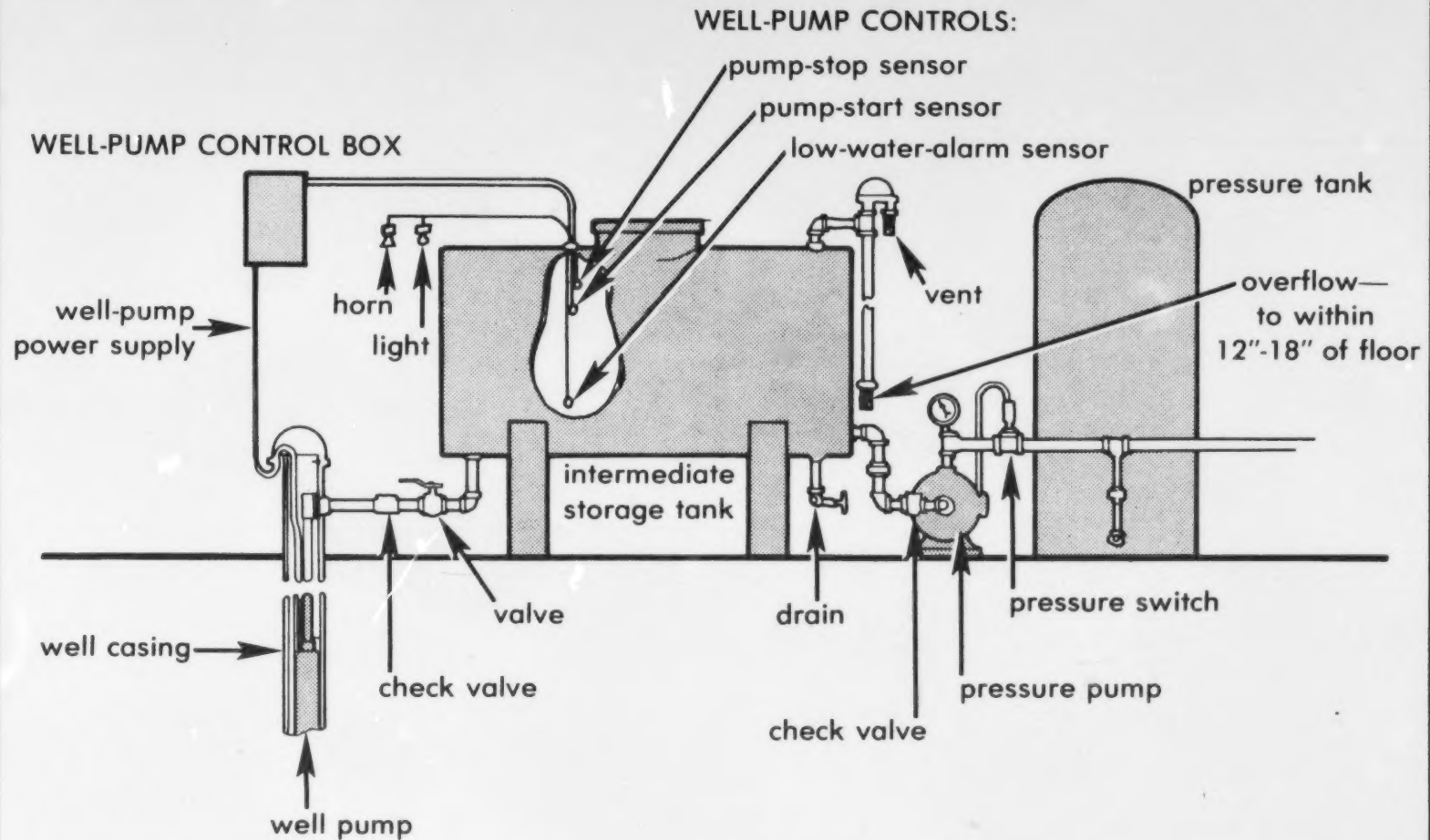
REPLACING
TRAP



CLEANOUT AUGER



WATER SYSTEM



AGRICULTURAL MECHANICS

UNIT D: Farm Water Supply and Sanitation

TOPIC 2: Skills Needed to Maintain Farm and Home Water System

Suggested Procedure and Activities: Students should be given the opportunity to perform the skills listed in this topic.

1. Reading Blueprints and Recognizing Plumbing Symbols

Before installing plumbing (considered to be any part of the water or waste disposal system) on the farm, or in a farm structure or dwelling, the farmer should have a detailed set of plans for the proposed plumbing. The preparation of detailed plans requires a lot of planning and forethought on the part of the farmer, as well as possibly securing the assistance of a professional plumber. In planning an adequate water and waste disposal system, there are several factors that must be considered. Some of these factors are source and availability of power (generally electricity), amount of water or other utilities needed at different locations, distance from source to outlets, pump capacity, storage capacity, the possibility of future expansion (it is expensive to install large fittings and other plumbing when remodeling), electrical protection, size and kind of pipe and fixtures available, and cost.

There are certain plumbing symbols which make it easier to prepare drawings and blueprints of a plumbing system. In order for a farmer to plan a farm water system and to read blueprints, he must be able to recognize these symbols. Some of the symbols are shown in the following transparencies.

Transparencies Nos. 1, 2, 3, 4 & 4b

Blueprints or drawings are necessary to determine the amount of pipe and fixtures needed for a plumbing job. They are also used as installation plans and help to determine costs. Plumbing drawings may be of two kinds, single line or double line. Transparency No. 5 shows examples of each.

Transparency No. 5

2. Selecting Pipe

The farmer has several choices when selecting the pipe to use for a given plumbing job. The different kinds of pipe, based on the materials used in their construction, are galvanized steel, black steel, copper, brass, cast iron, and plastic. All of the pipe listed above is not necessarily recommended for all plumbing jobs. General information about each kind of pipe is given in the following paragraphs.

Galvanized Pipe - More galvanized pipe is used for plumbing than any other kind. It is very durable and will last thirty to forty years under normal conditions. Galvanized pipe corrodes rather easily in alkaline and acid water and will burst if frozen. It can be purchased in three different weights: standard, extra strong, and double extra strong. The outside diameter of each weight is the same; however, the metal of the extra strong

and double extra strong is thicker. The extra strong and double extra strong are usually connected by flanges or welded; therefore, these are not usually used on farm plumbing jobs. Standard galvanized pipe can be purchased in a wide range of sizes. One-eighth inch is the smallest size, while twelve inches is the largest. Pipe size is determined by the diameter of the pipe opening or inside pipe size.

Black Steel Pipe - Black steel pipe may be purchased in the same sizes as the galvanized pipe. Because it corrodes so quickly, black steel pipe is not used on most plumbing jobs. It may be used as gas lines in areas where the pipe is protected from the weather and soil. It is the most economical pipe to buy.

Brass and Copper Pipe - Brass and copper pipes are interchangeable, but more copper is used than brass. There are two kinds of copper tubing, type K, a heavy duty pipe, and type L, the standard copper pipe. Copper tubing is resistant to corrosion and has a life expectancy of forty to 100 years. It can freeze several times before it will burst. Copper tubing is particularly useful in areas where rigid pipes are difficult to lay. It may be purchased in twenty-five foot coils, and there are nine outside dimension sizes from 1/8" to 1".

Plastic Pipe - There has been an increase in the amount of plastic pipe being used on farms. One of the reasons for this increase is the improvement in the quality of the pipe. Plastic pipe is easily laid and does not require any special tools. However, it is easily punctured, loses its strength under prolonged exposure to weather, and should not be used for hot water runs. Most city plumbing ordinances prohibit the use of plastic pipe inside of a home. It is available as rigid plastic pipe in 10 foot lengths and flexible plastic pipe in 60 foot coils. Several grades are available. If the pipe is to be used several years, the most economical plastic pipe to purchase is the best quality. Both fibre and plastic pipes are available in four-inch sizes and ten-foot lengths. There is also the perforated type used for septic tank drainage and subsurface field drainage. The solid type is used for house to sewer, downspout drainage, and non-pressure uses. Pipe are joined by driving them into a self sealing coupling.

Cast Iron Pipe - Cast iron pipe is used for drains and vents. The pipe ranges in size from two to twelve inches in diameter. The pipe may be purchased in five-foot lengths and in both single and double hubs (explained later). Cast iron pipe does not corrode and will last indefinitely.

After one has reviewed the advantages and disadvantages of the different kinds of pipe and the recommended uses of certain pipe, the following factors should be considered in determining the kind of pipe to use on a given job:

- a. Mineral or chemical content of water
- b. Resistance to corrosion
- c. Life expectancy
- d. Recommended pressure

- e. Resistance to deposits
- f. The use of the pipe
- g. Lengths available
- h. Cost

The factors to consider in determining the size of pipe to purchase are as follows:

- a. Amount of water needed at outlet
- b. Expected increase in water use at outlet
- c. Distance water must travel from source to outlet

3. Pipe Fittings

A part of any plumbing skill will be in developing the ability to recognize the different kinds of pipe fittings. Fittings can be purchased in the same sizes as pipe. Some fittings that may be used with different kinds of pipe are shown in the following transparencies.

Transparencies Nos. 6, 7, and 8

The plastic fittings shown in Transparency No. 8 are used with a clamp. There are also plastic fittings that may be glued to the pipe.

Fittings make pipe much easier to install and are used in the following ways:

- a. To connect pipe
- b. To change the direction of pipe
- c. To reduce the size of pipe
- d. To plug pipes

Fittings have the same inside dimension as the pipe they are used on and are designated by the size of pipe they fit. For example, one-inch tees fit one-inch pipe.

Transparency No. 8a

Making Plastic to Plastic Connections

After the pipe is cut with a fine-toothed hacksaw, it should be reamed with a pocket knife or reamer. Both the fitting socket surface and the surface of the pipe which will fit into the socket should be thoroughly cleaned.

Using the proper solvent or cement for the type of pipe (standard or drainage plastic piping) and a non-synthetic bristle brush, apply the solvent or cement generously to the inside and outside of the surfaces to be fitted.

When the surfaces are completely and evenly covered with cement or solvent, press the pipe and fitting firmly together, turning the pipe 1/4-turn to evenly distribute the cement. Hold the pieces together for 15 seconds to allow curing to take place. Clean off the excess solvent. Check for accuracy and allow the connection to weld or set.

Transparency No. 9a & 9b

There are several kinds of valves used in plumbing. The most common are the safety, check, hydrant, stop and waste, gate, and globe. Safety valves are used on hot water heaters to release water and temperature. When the pressure on the spring is exceeded by the pressure under the seat, the seat is lifted, and water and air flow through.

Check valves are used to prevent a backflow of water. They are automatic and open and close with the direction of flow.

Globe valves are used to cut off the flow of water or to drain the water line. It should be installed with the pressure under the valve seat. Otherwise, it will leak. The gate valve is used the same way as a globe valve. It has an advantage over the globe valve; it will not restrict the flow of water.

There are two types of stop and waste valves, globe and ground key. They are used to shut off the pressure and drain the line.

A hydrant valve is similar to a stop and waste valve. When the water is turned off, the pipe is drained from the surface back to the valve. This prevents freezing in cold weather.

4. Plumbing Tools

In order to install pipe and plumbing, certain tools are needed. The following transparency shows most of the tools needed to install plumbing.

Transparency No. 10a, 10b, & 10c

Pipe Vise - The farmer may use a combination pipe and machinist's vise or a regular pipe vise. Three different kinds are shown in the transparency.

Pipe Cutter - A small amount of pipe may be cut with a hacksaw; however, pipe cutters require less effort and generally make a straighter and smoother cut. Galvanized pipe cutters and tube cutters are available.

Stocks and Dies - Several brands are available, and there is some variation in quality among the different brands.

Pipe Wrenches - Several kinds and sizes of wrenches are available. Usually two wrenches are needed to tighten and loosen pipes. The farmer should select wrenches that are large enough for the job.

Burring Reamer - A burr is made on the end of a pipe while it is being cut. A reamer should be used to remove the burr. Two types of reamers are shown in the transparency. One is used on galvanized pipe, while the other is for copper tubing. The copper tubing reamer is a part of the tube cutter.

Flare Tool - The flare tool is used to form a flare on the ends of copper tubing when flare type fittings are used.

5. Measuring, Marking, Cutting, and Reaming Pipe

To accurately measure the length of a pipe, one must know the distance that the pipe screws into the fitting and the distance taken up by the fitting. Different size pipe and fittings require different distances. Charts are available that give the distances taken up by fittings and the distance pipe is screwed into fittings. Transparency No. 4 shows the area to measure to determine the length of several fittings. After using various fittings on plumbing jobs several times, one will learn the distances taken up by each size fitting.

Transparency No. 11

Measuring Pipe: There are three methods of measuring pipe:

- a. The distance between the fittings is measured, and an allowance is made for the thread that screws into the fitting. One-half inch should be allowed for the fitting if one inch pipe is used, and three-fourths of an inch of thread is allowed for pipe $1\frac{1}{2}$ inches to two inches in diameter. This method should not be used when accurate measurements are needed.
- b. A more accurate method for measuring pipe is to measure the distance from the center of one pipe to the center of the other pipe (as shown in Transparency 11, Figure B) and subtract the diameter of the pipe for each thread. A farmer using one-inch pipe, for example, would subtract two inches from the length of the pipe, one inch for each end of the pipe.
- c. When pipe larger than $1\frac{1}{2}$ inches in diameter is used, the distance to the center of the pipe is measured, and the fittings are measured from the center of the pipe to the back of the thread of the fitting, see Transparency No. 11, Figure C.

Marking Pipe - The length of the pipe may be measured with a ruler or tape measure, and the pipe should be marked with the edge of a three-cornered file.

Cutting Pipe - To prepare pipe for cutting, the farmer should fasten the pipe in a pipe vise with the mark made by the file approximately four inches in front of the vise. The procedure for cutting the pipe is as follows:

- a. The opened pipe cutter is slipped over the pipe, and the cutter handle is turned until the wheels are snug against the pipe at the mark.
- b. A few drops of oil (cutting oil) are placed on the mark.
- c. The pipe cutter is turned around the pipe, and the screw handle is turned one-fourth turn each revolution of the cutter until the pipe is cut off.
- d. The reamer is used to remove the burr that is left on the inside of the pipe after it is cut. If the burr is left in the pipe, it will restrict the flow of water.

6. Threading Galvanized and Black Pipe

A pipe thread is tapered so that it will make a tight joint when the fitting is screwed on to the pipe. In order for the joint to be tight, the thread must be cut properly. The procedure for cutting a pipe thread is as follows:

- a. The pipe is cleaned of dirt, rust, and other materials.
- b. The rough edges are removed from the end of the pipe to be threaded.
- c. The pipe is secured in a vise.
- d. Cutting oil or lard oil is applied to the die.
- e. Inward pressure is applied to the die as it is turned on the pipe. After the die becomes engaged on the pipe, the inward pressure should be discontinued.
- f. The pipe should be oiled frequently ahead of the die.
- g. The threading is continued until one thread is showing outside of the die. More threads should be showing on large pipe. The die should never be turned backwards or back and forth. This will ruin the threads.
- h. The die is backed off of the threads carefully. If the die should catch, it should be turned forward again to dislodge the metal chips.
- i. The pipe is cleaned of oil and removed from the vise. The die also should be cleaned.

7. Flaring Copper Tubing

When flare type fittings are used, it is necessary to make a flare at the ends of the tubing. The procedure for flaring the tubing is as follows:

- a. A sleeve nut is slipped on the section of copper tubing.
- b. The burr, if present, should be removed from the end of the tubing.
- c. The tubing is wrapped with cloth or leather (to prevent marring) and placed in a vise.
- d. A few drops of oil are applied to the flaring tool.
- e. The flaring tool is placed over the end of the tubing, and the tubing is placed flush with the surface of the tool.
- f. The flaring tool is screwed into the end of the tubing to make a flare.
- g. The flare tool is removed, and the sleeve nut is placed in position. The flared end is now ready to be placed on the fitting.

8. Assembling Tubing with Solder Fittings

Transparency No. 11a

A gas soldering or brazing torch is recommended for soldering fittings. Also, a flux, recommended for use with the solder, should be used. The following is a step by step procedure for assembling copper pipe with solder fittings.

- a. The copper tubing is cut square, and the burr is removed.
- b. The outside area of the tubing that will be covered with the fitting is cleaned thoroughly.
- c. The inside of the fitting is cleaned thoroughly.
- d. Flux is applied to the cleaned portion of the tube.
- e. The fitting is placed on the tubing, pushed against the shoulder of the fitting, and turned several times to distribute the flux.
- f. Heat is applied until the flux boils and the copper will melt solder.
- g. Solder is applied until it appears completely around the edge of the fitting. Because of the close fit of the fitting and the pipe, the solder will flow by capillary action throughout the joint when the joint is properly heated. This action is in every direction - up, down, or sideways. The flame should be removed from the joint as quick as the joint is filled with solder. Excessive heat will cause the solder to boil out of the joint.
- h. The joint is allowed to cool.

9. Measuring, Cutting, and Assembling Cast Iron Pipe

This type of pipe is often referred to as cast iron soil pipe because it is used for drains and vents and is in contact with the soil.

When measuring cast iron pipe, an allowance should be made for the hub. Different size pipe require a different allowance. After the pipe has been measured, a mark, which will indicate the area to cut, should be made with chalk around the pipe.

When ordering cast iron pipe, the farmer should order enough double hub pipe to make all of the cuts from. Cast iron pipe may be cut by three methods: a cast iron pipe cutter, a hacksaw, or a chisel. An explanation of cutting cast iron pipe with a hacksaw and chisel is given in the following paragraphs.

Transparency No. 12

If a hacksaw is used, a 1/16 inch deep cut is made around the pipe. After the cut is made, the pipe is tapped with a hammer until it breaks. The hacksaw should be used only on service weight pipe. A cutter or a cold chisel should be used on heavier pipe.

When a cold chisel is used to cut the extra heavy weight pipe, the farmer should place the pipe on a board as shown in the transparency. A file is used to mark the pipe, and a chisel is used to make a light cut around the pipe. The pipe is rolled on the board as it is cut.

There are two kinds of joints that are used in connecting cast iron pipe. These are vertical and horizontal. The procedure to follow in making a vertical joint is as follows:

- a. The hub is placed in an upright position.
- b. The pipe and joint are cleaned, and the spigot end is placed into the hub its full depth.
- c. Oakum, a form of rope, is wrapped around the pipe and packed with the yarning iron. The joint is filled within $3/4$ inch from the top of the hub. The oakum must be packed tightly and evenly to make a water proof joint.
- d. Molten lead is poured into and around the joint. Enough lead should be picked up in the ladle to fill the joint in one pouring.
- e. The lead is allowed to cool, and the joint is calked (packed) to make it water-tight. A hammer and calking iron are used for this.

The procedure for assembling a horizontal joint is the same, except an asbestos joint runner is used to pour the lead in the hub.

10. Sewage Disposal System

Transparency No. 13

Plans for the sewage disposal system should be developed at the same time as the water system because an adequate sewage disposal system is necessary to safeguard health and prevent disease.

Sewage passes through three stages before it becomes harmless: sedimentation, decomposition, and purification. The solids are separated by the liquids in the sedimentation stage, while two types of bacterial action (aerobic and anaerobic decomposition) cause their decomposition. These bacteria will usually establish themselves in a septic tank; however, they may be purchased commercially and placed in the septic tank. The purification of sewage is accomplished as the liquid is aerated through the soil in the disposal field.

The most inexpensive method of sewage disposal for the farm home is a septic tank with an underground disposal system. However, in some areas it may not be possible to use this system. Heavy, impervious soil or a high water table will prevent the use of a septic tank. Before installing this type of sewage disposal, one should run a percolation test to determine if a septic tank and underground disposal system will function properly.

The three parts of a sewage system are the sewer line from the house to the septic tank, septic tank, and final disposal system. Each will be discussed separately:

Sewer Line from the House to the Septic Tank - The length of the sewer line to the septic tank will be determined by the slope of the ground, location

of house and well, and the disposal field. All sewer lines should be located to prevent contamination of the well by sewage.

The drain line should be laid in a straight line and at a uniform grade. The grade of the drain is determined by the size of the line, but not less than two feet per 100 feet of line is recommended for four-inch drain pipe. Less drop may be used on larger pipe. The pipe should be laid on firm soil.

Septic Tank - The septic tank can be purchased, or it may be constructed on the site. The size of the septic tank should be determined by the number of people in the family plus others that may be expected to use the system. It should be large enough to hold the sewage for three days. A daily allowance of forty to fifty gallons per person is usually made. The septic tank should be located down hill from the home and no closer than thirty feet.

The contents of a septic tank are composed of scum, liquid, and sludge. Grease and lighter solids rise to the top to form scum, and the heavier solids sink to the bottom. Liquid remains in between. The outlet on the septic tank is constructed so as to prevent solids from leaving the tank.

Final Disposal System - Since only liquid passes through the outlet line, it is not easily clogged; nevertheless, a grade of two feet for 100 feet should be used. This will increase its capacity and decrease the possibility of freezing.

The size of the disposal area is very important and is determined by the capacity of the soil to absorb liquid, size of the disposal system, amount of liquid to be disposed, and size of trench where pipes are laid. There are several ways of running disposal lines, and they may be of cast iron, vitrified clay cement, or fiber tile. Some systems have the disposal lines running from a distribution box, while others have the lines running directly from the septic tank. Regardless of the layout of the disposal tile, one should have at least two runs of tile equal in length. The runs should not exceed 100 feet in distance.

The grease trap, which is connected to the kitchen sink and is another part of the waste disposal system, may be connected to the septic tank, or it may bypass the septic tank and go directly to the disposal lines.

Some farms need a liquid manure disposal system. If the fertility of the manure is utilized, a large septic tank can be built for this purpose. A mobile liquid manure spreader will be needed to distribute the manure. Some farmers use lagoons, a large pond, to dispose of manure.

References:

1. Wright, Forrest B., Rural Water Supply and Sanitation, John Wiley and Sons, Inc., New York, New York.
2. Phipps, Lloyd Jr., Mechanics in Agriculture, The Interstate Printers and Publishers, Inc., Danville, Illinois.

3. Wakeman, T. J., Modern Agricultural Mechanics, The Interstate Printers and Publishers, Inc., Danville, Illinois.
4. Sears, Roebuck and Co., "Plumbing Handbook", Chicago, Illinois.

PLUMBING SYMBOLS

FIXTURE

WATER CLOSETS



LOW TANK

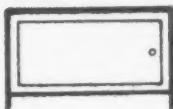


NO TANK
(flush valve)

BATHS



CORNER



RECESSED

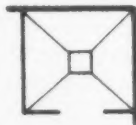


ANGLE TUB

SHOWERS



SHOWER
STALLS



SHOWER
HEAD

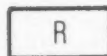


OVERHEAD
GANG
SHOWER



METER

GAS RANGE



HOT WATER

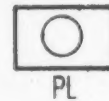


TANK



HEATER

LAVATORIES



PEDESTAL



WALL



CORNER



MANICURE
OR
MEDICAL



DENTAL

OUTLETS



GAS



VACUUM

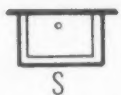
PLUMBING SYMBOLS

FIXTURE (con't)

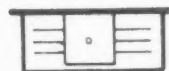
SINKS



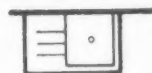
DISHWASHER



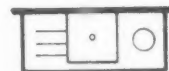
PLAIN KITCHEN



KITCHEN, R&L
DRAIN BOARD



KITCHEN, L.H.
DRAIN BOARD



COMBINED SINK
& DISHWASHER



COMBINED SINK
& LAUNDRY TRAY



SERVICE



WASH (wall type)



WASH (free-standing)

LAUNDRY TRAY



HOSE RACK



HOSE BIBS OR FAUCET



WASHING MACHINES



WRINGER

WM



AUTOMATIC

DRYERS



CENTRIFUGAL



CABINET



RACK



DRAIN

DRAINS



GARAGE



FLOOR, WITH
BACKWATER VALVE

DRAINAGE



LAMP HOLE DRAIN



LEADER DRAIN



DRY WELL



RECEIVING BASIN



YARD DRAIN INLET

PLUMBING SYMBOLS

PIPING SYMBOLS

PLUMBING

SOIL, WASTE OR LEADER (above grade) . .	_____
SOIL, WASTE OR LEADER (below grade) . .	_____
VENT	_____
COLD WATER	_____
HOT WATER	_____
HOT WATER RETURN	_____
FIRE LINE	— F — F —
GAS	— G — G —
ACID WASTE	_____ ACID _____
DRINKING WATER FLOW	_____ - - - - -
DRINKING WATER RETURN	_____ - - - - -
VACUUM CLEANING	— V — V —
COMPRESSED AIR	_____ A _____

SPRINKLERS

MAIN SUPPLIES	_____ S _____
BRANCH AND HEAD	_____ O _____ O _____
DRAIN	_____ S _____ S _____

PNEUMATIC TUBES

TUBE RUNS	=====
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DRAINAGE

SEWER-CAST IRON	_____ S-CI _____
SEWER-CLAY TILE, BELL & SPIGOT	_____ S-CT _____
DRAIN-CLAY TILE, BELL & SPIGOT	_____ - - - - -
DRAIN-OPEN TILE OR AGRICULTURAL TILE	_____ - - - - -



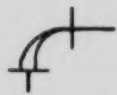
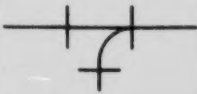
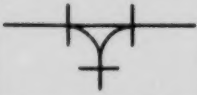
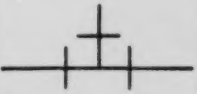
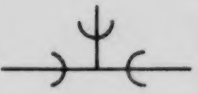
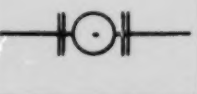
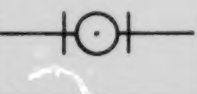
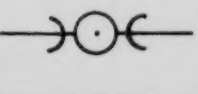
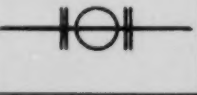
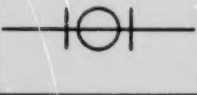
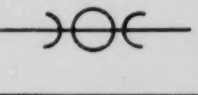
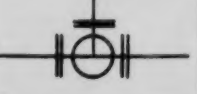
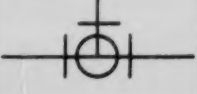
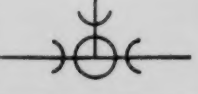
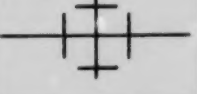
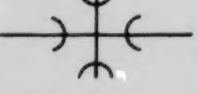
PLUMBING SYMBOLS

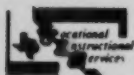
PIPE FITTINGS

FITTING	FLANGED	SCREWED	BELL AND SPIGOT
joint			
elbow-90°			
elbow-45°			
elbow-turned up			
elbow-turned down			
elbow-long radius			
side outlet elbow outlet up			
side outlet elbow outlet down			
base elbow			
double branch elbow			

PLUMBING SYMBOLS

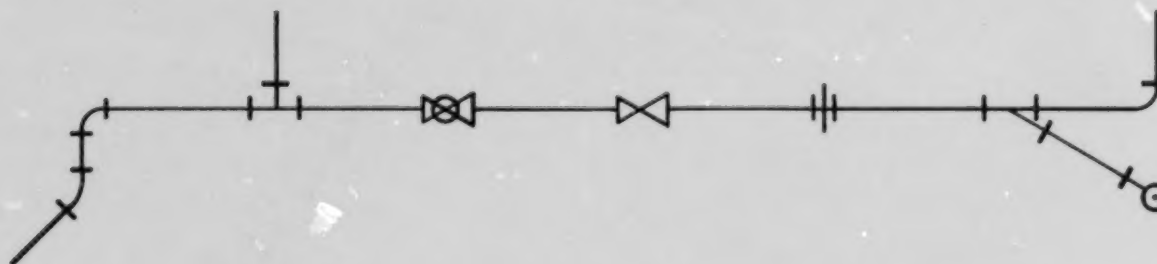
PIPE FITTINGS (con't)

FITTING	FLANGED	SCREWED	BELL AND SPIGOT
reducing elbow			
single sweep tee			
double sweep tee			
tee			
tee-outlet up			
tee-outlet down			
side outlet tee outlet up			
side outlet tee outlet down			
cross			

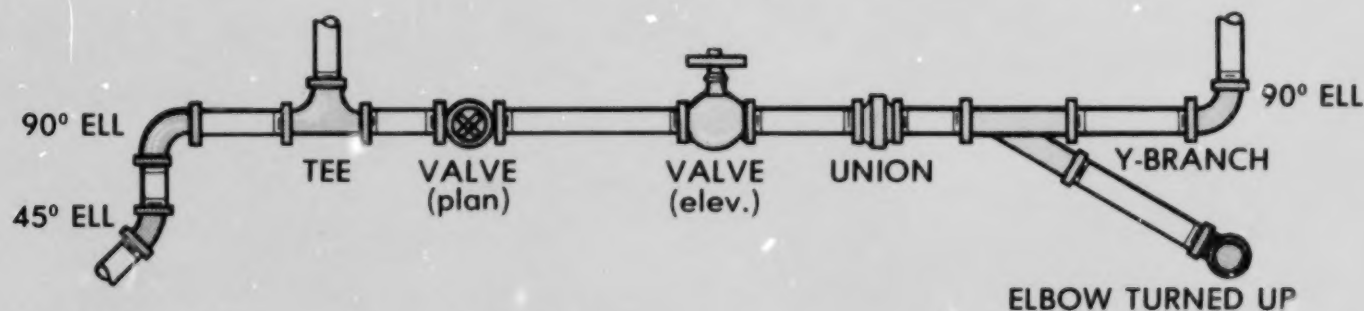


EXAMPLES OF SINGLE AND DOUBLE LINE DRAWINGS

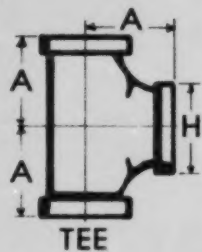
SINGLE LINE DRAWING



DOUBLE LINE DRAWING



KINDS OF PIPE FITTINGS STANDARD



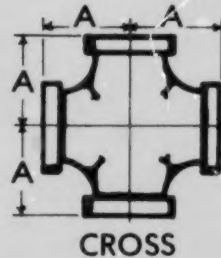
TEE



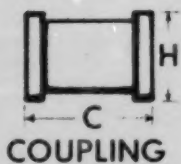
90° ELL



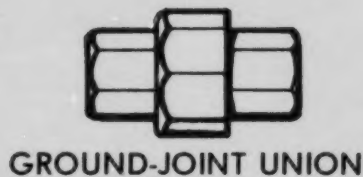
45° ELL



CROSS



COUPLING



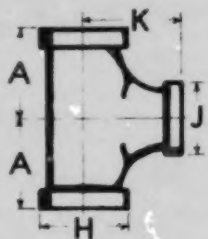
GROUND-JOINT UNION



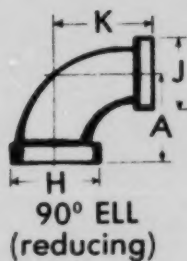
RETURN BEND



EXTENSION PIECE



TEE (reducing)



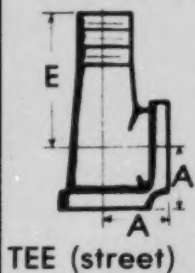
90° ELL
(reducing)



REDUCER



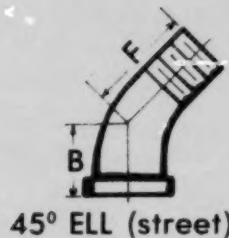
PIPE CAP



TEE (street)



90° ELL (street)



45° ELL (street)



DROP-EAR ELL



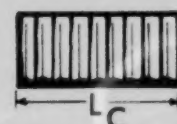
FLOOR FLANGE



PLUG



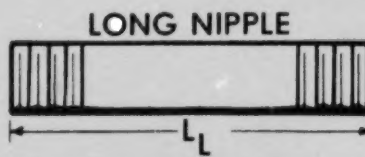
BUSHING



CLOSE NIPPLE



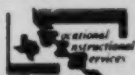
SHORT NIPPLE



LONG NIPPLE

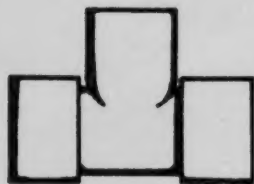


TANK NIPPLE



COPPER PIPE FITTINGS

SOLDER TYPE



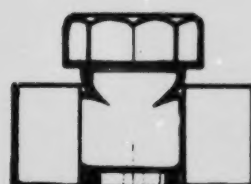
TEE



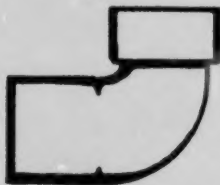
TEE



REDUCING TEE



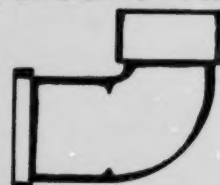
DROP-EAR TEE



90° ELL



90° ELL
(adapting)



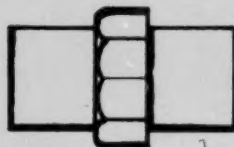
90° ELL
(adapting)



DROP-EAR ELL



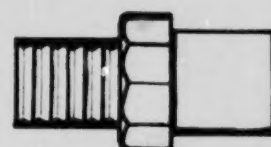
45° ELL



UNION



REDUCING ADAPTER



ADAPTER



COUPLING



FLUSH
BUSHING



END
CAP

FLARE TYPE



90° ELL



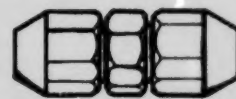
90° ELL
(adapting)



90° ELL
(adapting)



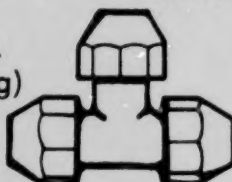
FLARING TOOL



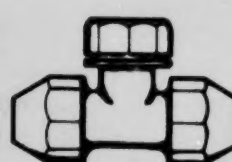
UNION



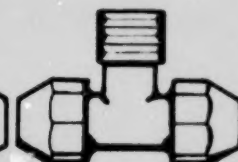
ADAPTERS



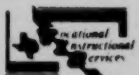
TEE



TEE
(adapting)



TEE
(adapting)



KINDS OF PIPE FITTINGS

CAST IRON FITTINGS



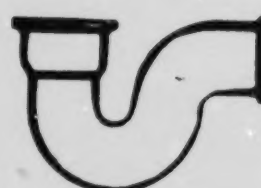
Y-BRANCH



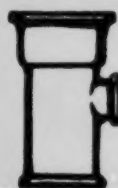
TEE-BRANCH



QUARTER BEND
WITH INLET



P-TRAP



SANITARY
TEE-BRANCH
WITH TAPPED INLET



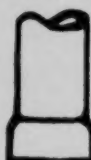
CLOSET BEND
WITH INLET



QUARTER
BEND



EIGHT
BEND



LEAD
FERRULE



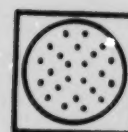
OFFSET



REDUCER

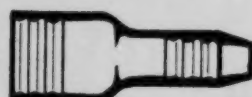
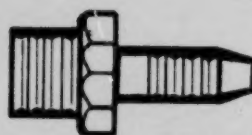


SCREW
FERRULE



FLOOR
DRAIN

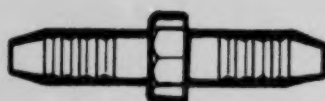
PLASTIC FITTINGS



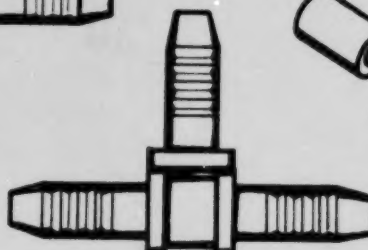
ADAPTERS



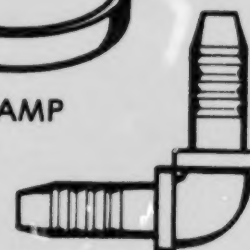
CLAMP



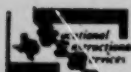
COUPLING



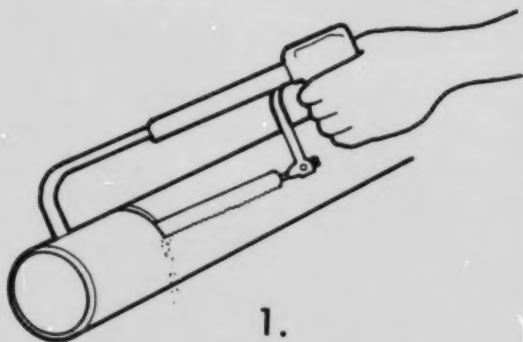
TEE



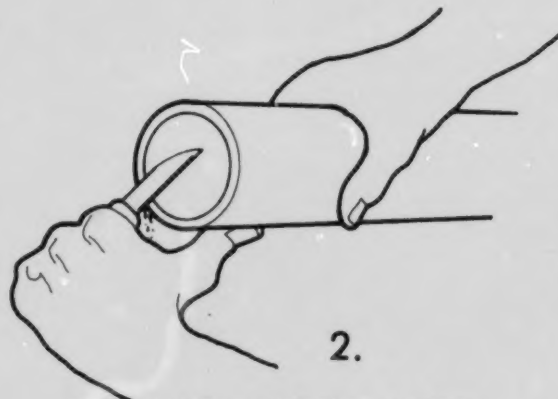
90° ELL



PLASTIC TO PLASTIC CONNECTIONS



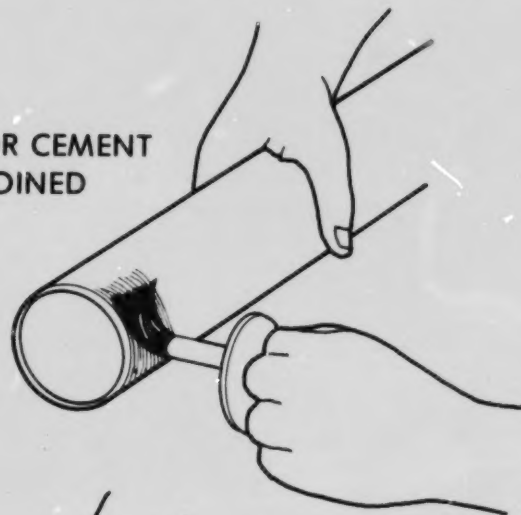
CUT WITH FINE-TOOTHED HACKSAW



REAM WITH POCKET KNIFE



APPLY PROPER SOLVENT OR CEMENT
TO SURFACES TO BE JOINED

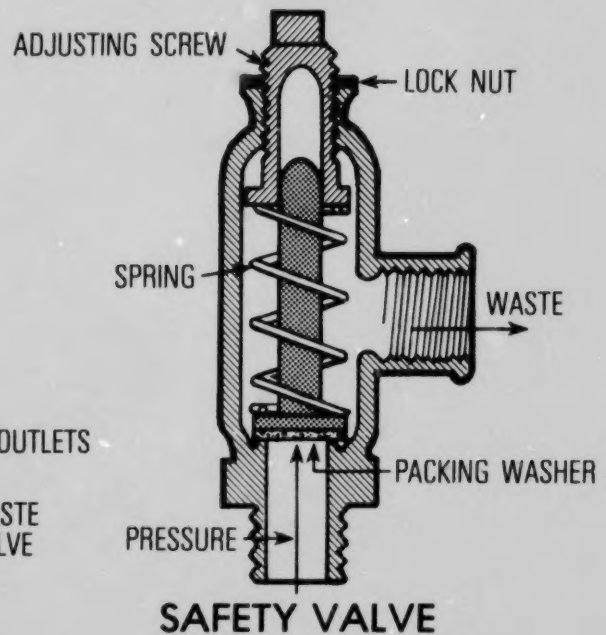
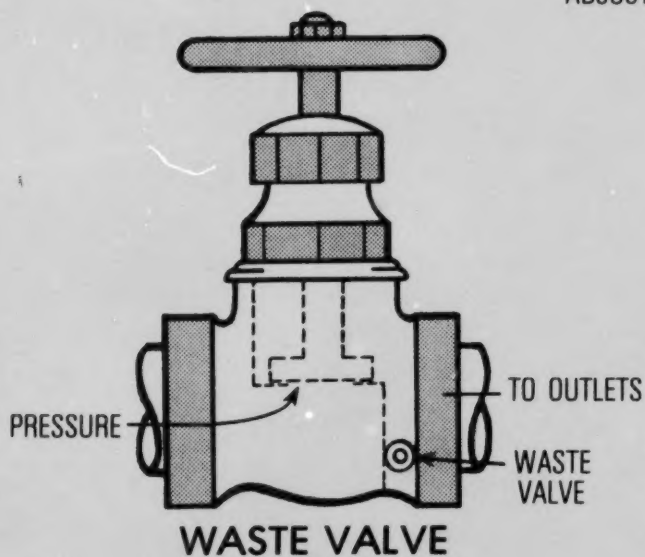
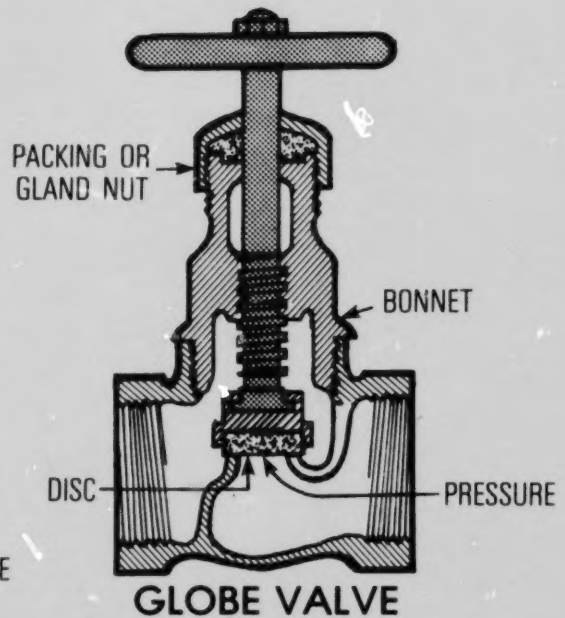
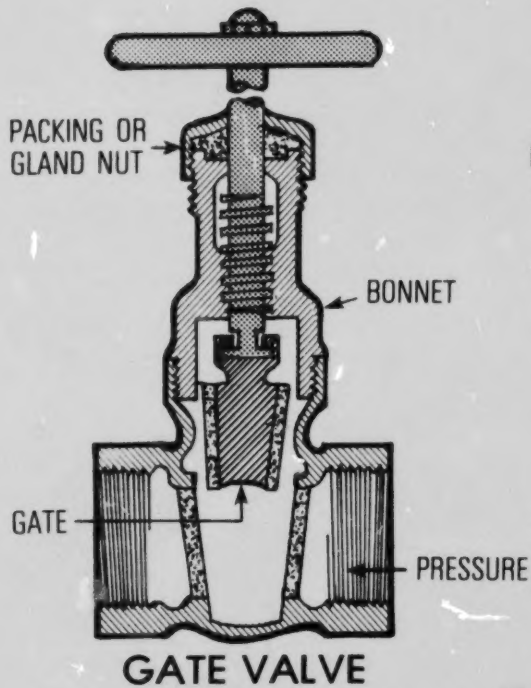


PRESS TOGETHER FIRMLY
AND TURN $\frac{1}{4}$ TURN



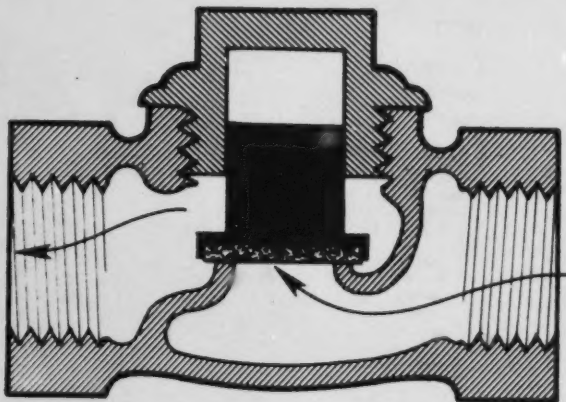
HOLD FOR 15 SECONDS TO SET

KINDS OF VALVES

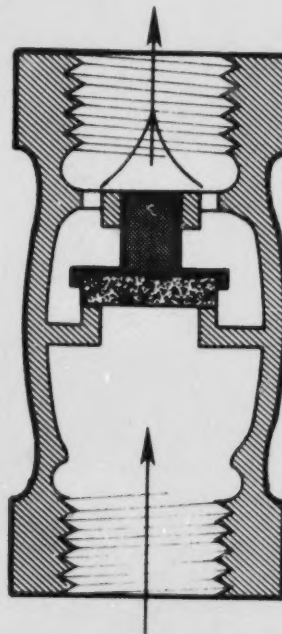


KINDS OF VALVES

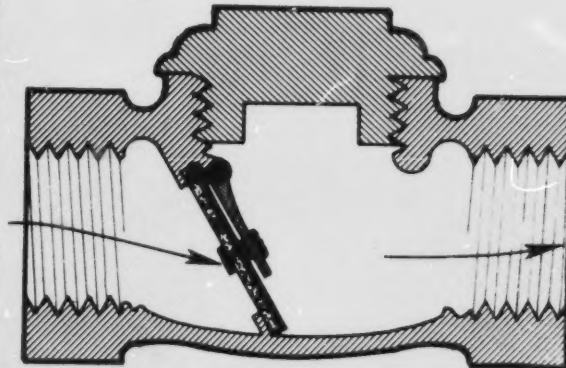
CHECK VALVES



HORIZONTAL CHECK

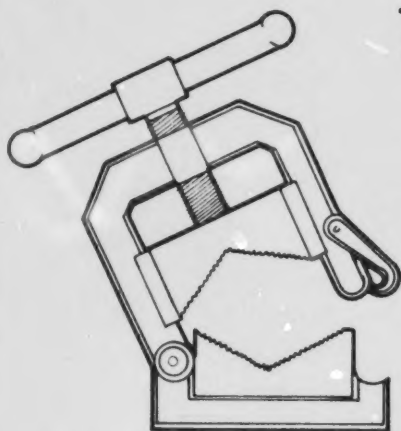


VERTICAL CHECK

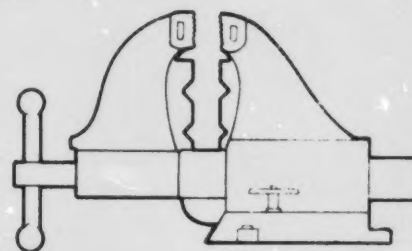


SWING CHECK

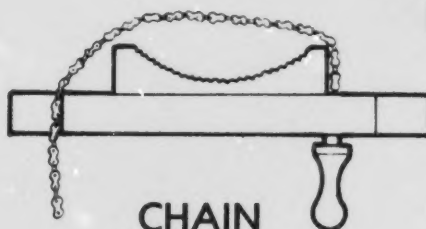
TYPES OF VISES



HINGED PIPE VISE

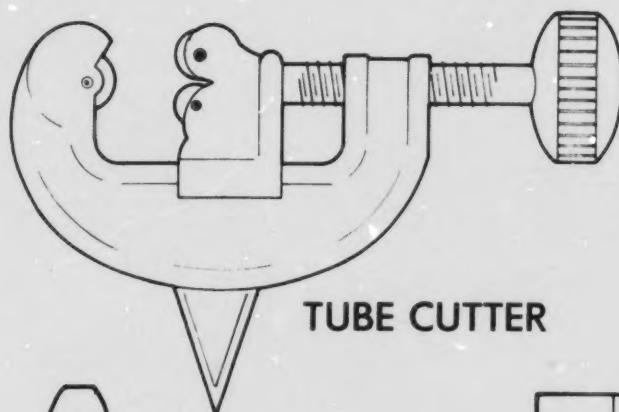


COMBINATION
PIPE VISE

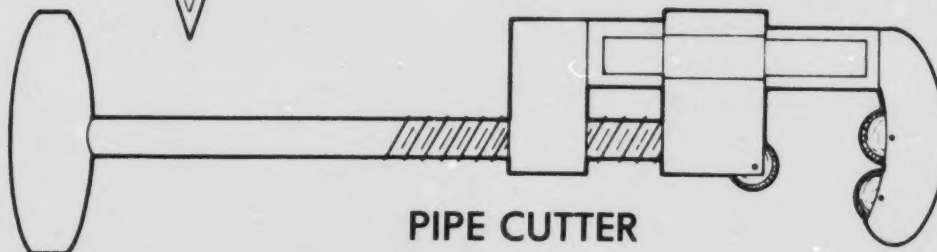


CHAIN
PIPE VISE

TYPES OF CUTTERS

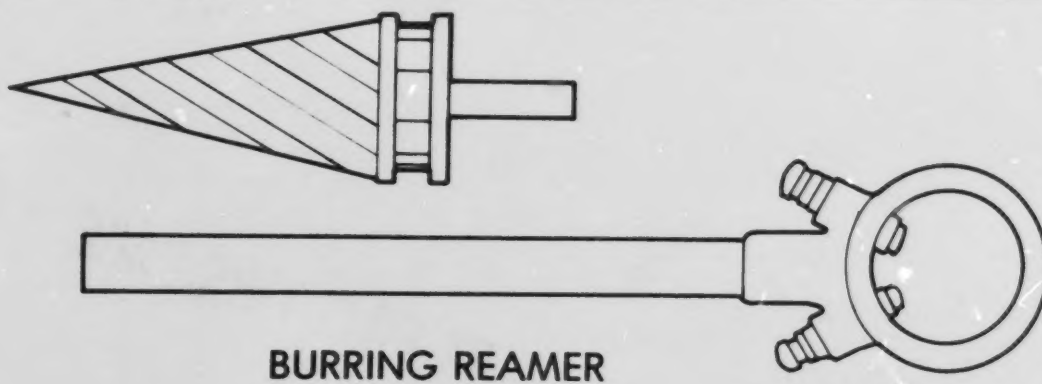
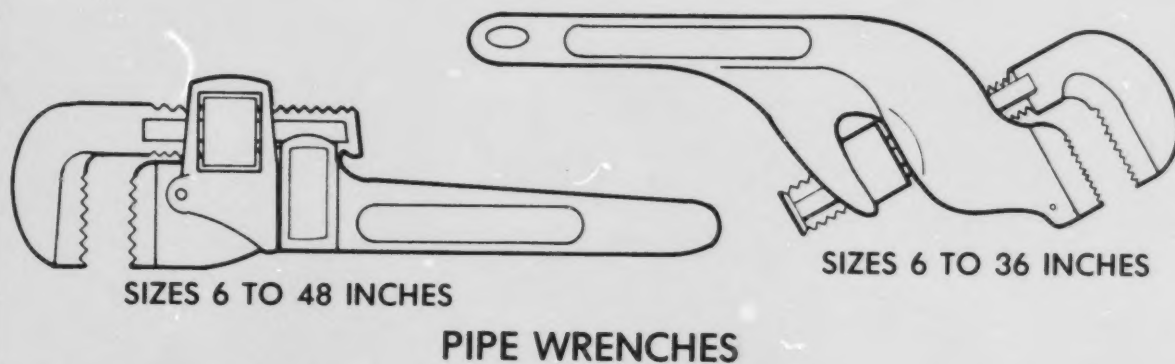
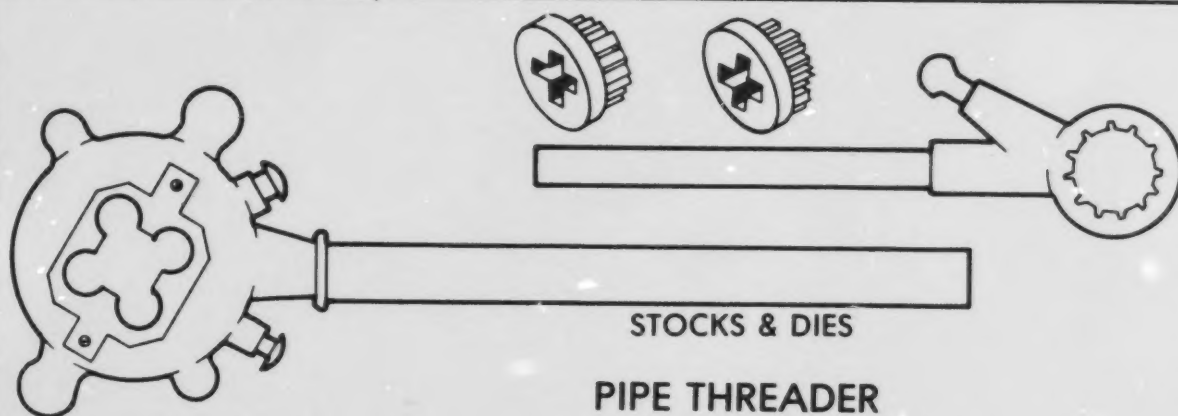


TUBE CUTTER



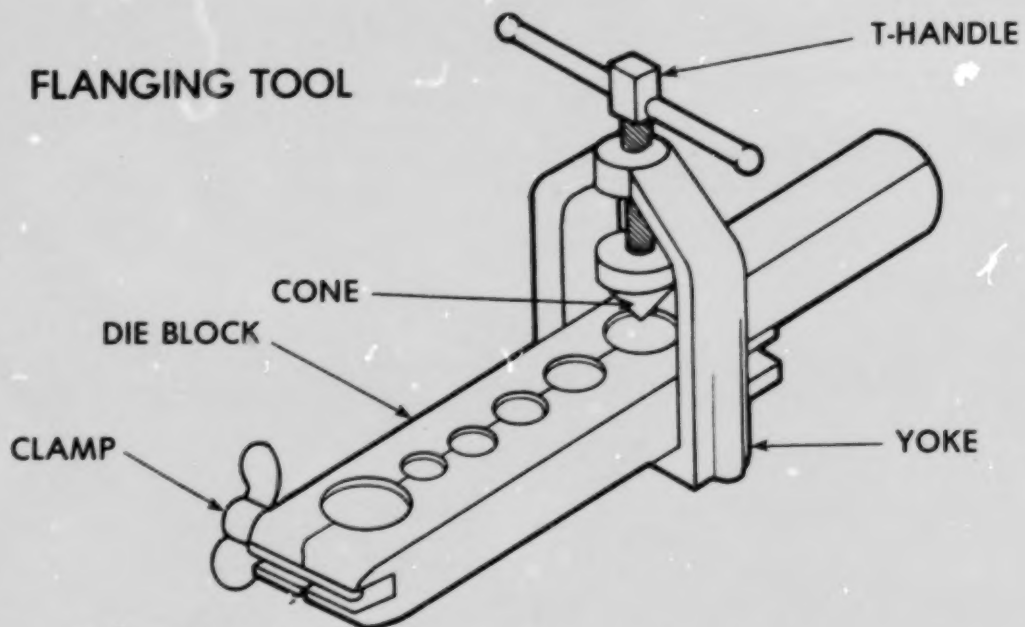
PIPE CUTTER

PLUMBING TOOLS

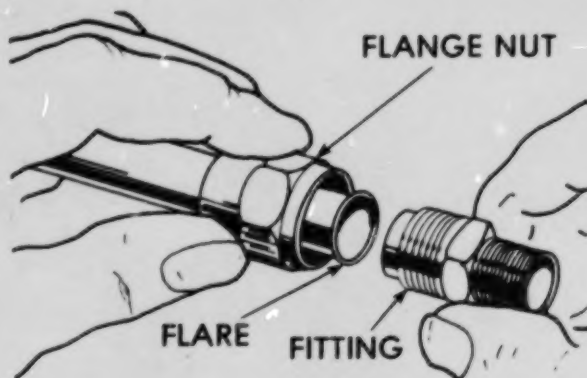


PLUMBING TOOLS

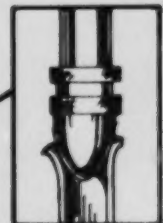
FLANGING TOOL



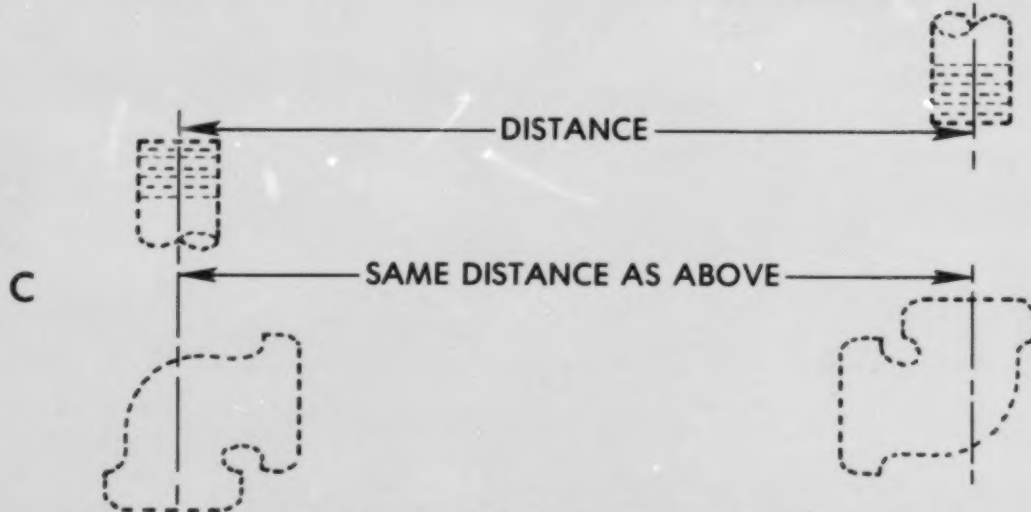
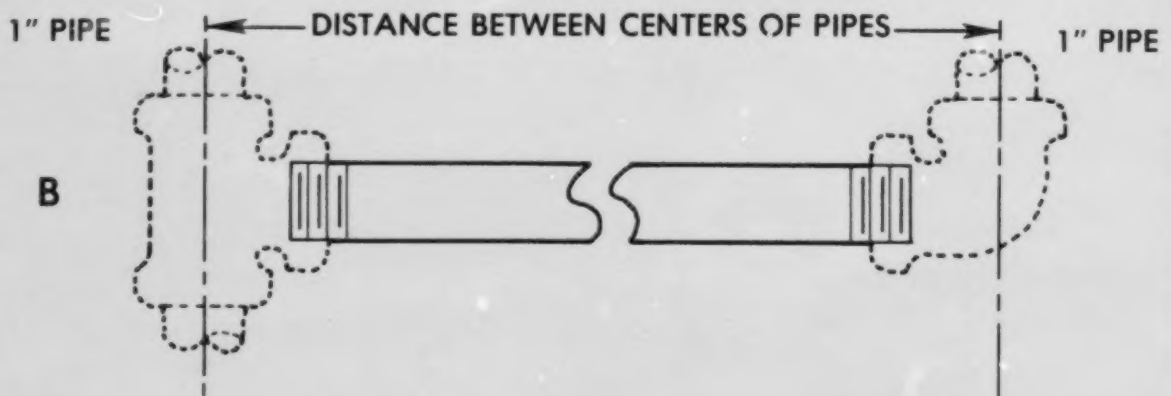
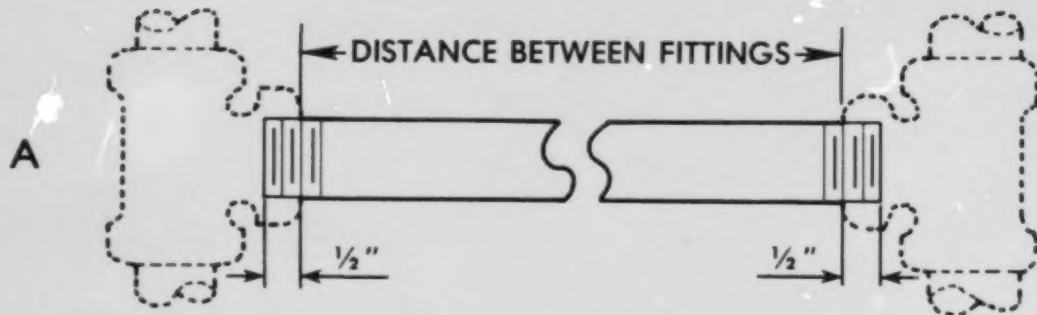
FLARING TOOL & HAMMER



Tool must be centered and straight. Tap it in until flare fills recess in nut.



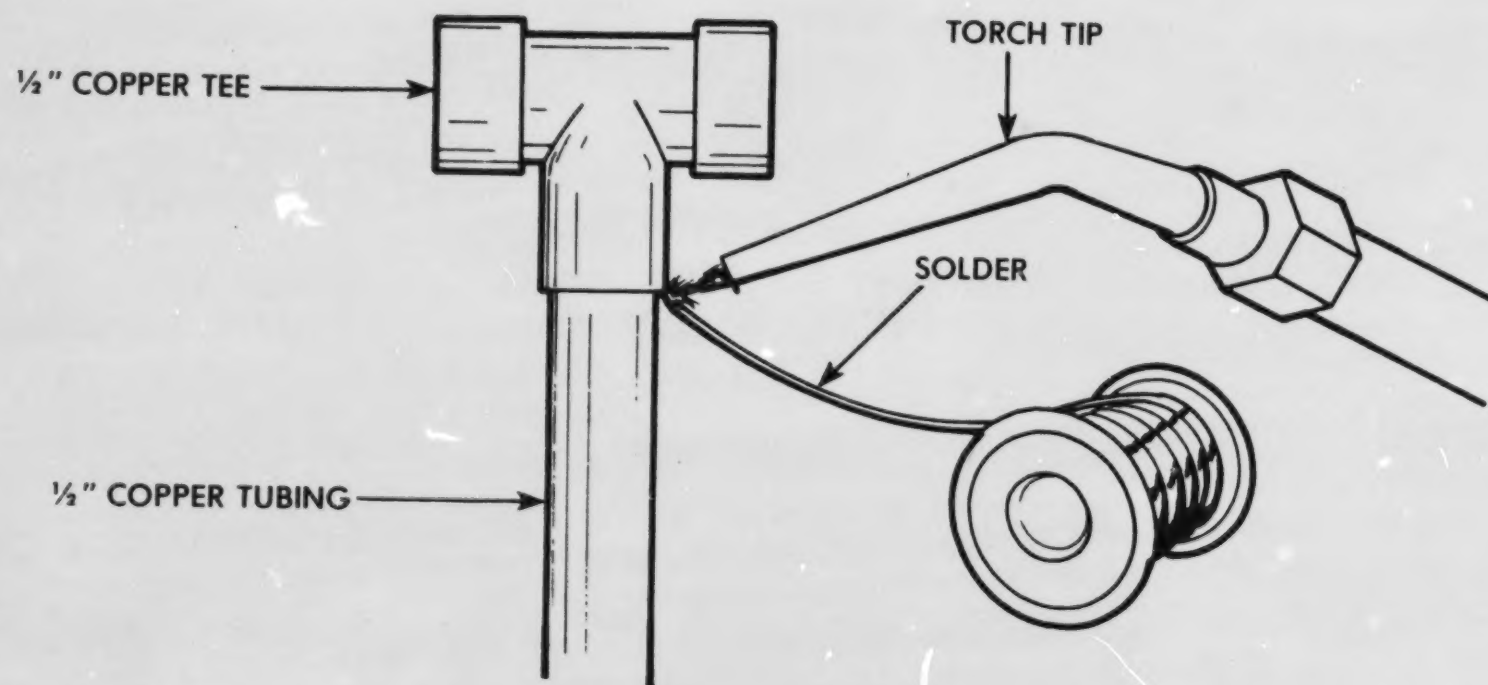
MEASURING PIPE



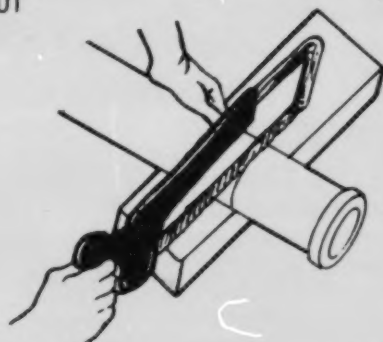
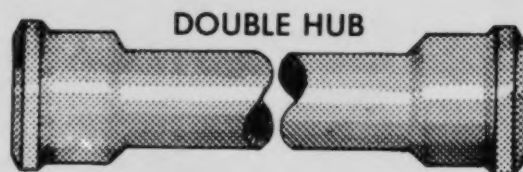
DISTANCE IS MEASURED AND WILL BE DISTANCE TO CUT PIPE



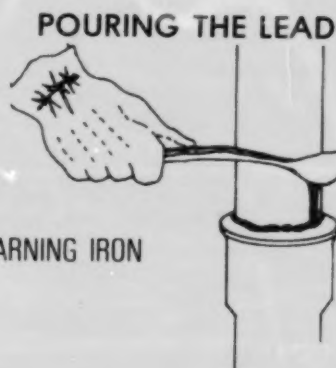
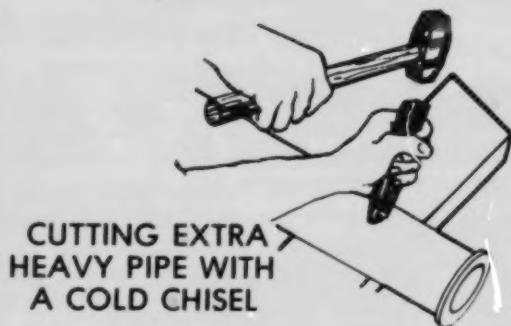
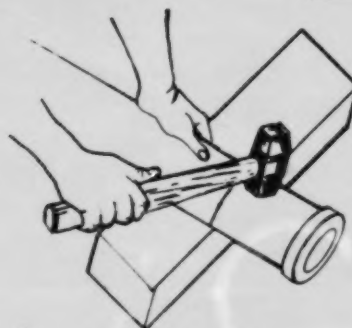
ASSEMBLING COPPER TUBING WITH SOLDER FITTINGS



CUTTING AND ASSEMBLING CAST IRON SOIL PIPE



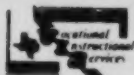
CUTTING WITH
A HACKSAW



PACKING LEAD
WITH A
CAULKING IRON

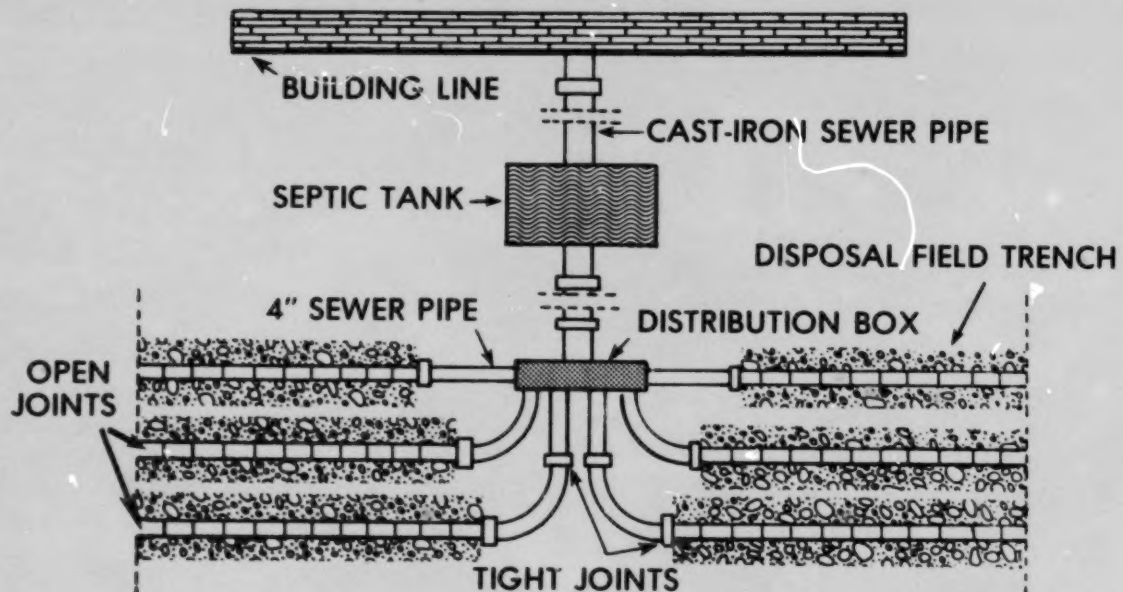


POURING LEAD IN A HORIZONTAL
JOINT WITH THE USE OF AN
ASBESTOS JOINT-RUNNER

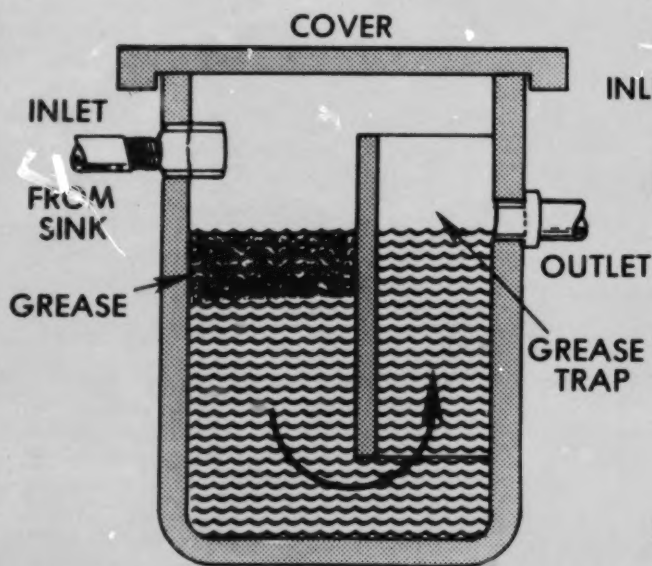


SEWAGE DISPOSAL

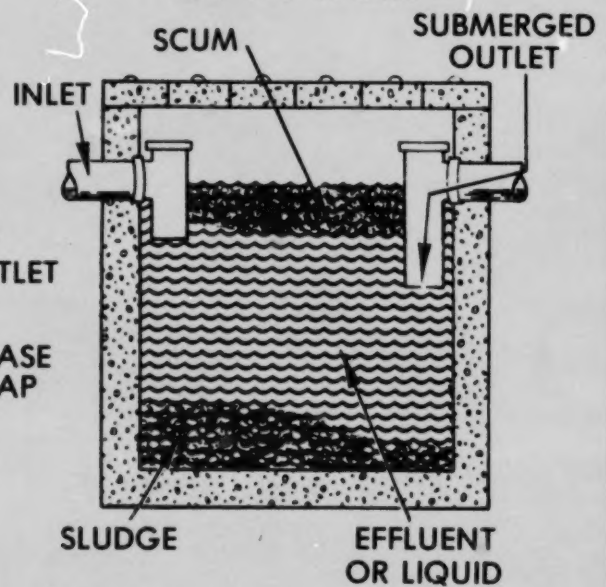
DISPOSAL FIELD



GREASE TRAP



SEPTIC TANK



AGRICULTURAL MECHANICS

UNIT E: Farm Level

TOPIC 1: Setting Up and Using Tripod Level

Suggested Procedures and Activities: The students should be given practice exercises in setting-up, testing, and adjusting the level.

1. Kinds of Tripod Levels

There are several kinds of tripod levels which vary considerably in quality, cost and accuracy. The most common types of tripod levels are the wye, dumpy, architect's, drainage, and farm level.

The wye level is the most expensive and gets its name from the method used to attach the telescope to the rest of the level. The telescope, attached by two wyes, may be easily removed and adjusted. This level may have either three or four leveling screws.

The dumpy level has a bubble tube attached to the telescope which is difficult to remove from the rest of the level. It is cheaper and easier to adjust than the wye and may have either three or four leveling screws.

The architect's and drainage levels are similar to the dumpy and have plumb bob attachments (an attachment used at a given point of location).

The farm level is also similar to the dumpy level. It is adequate for most farm jobs, inexpensive, simple to use, accurate, and with proper care will give excellent service. The two types of farm levels are the turret and the utility. The turret type has three leveling screws, while the utility type has four leveling screws.

2. Transporting the Tripod Level

A level must be handled and transported properly if it is to be accurate and give service. Suggestions for handling and transporting a level are as follows:

- a. The level should be protected from shock and vibration.
- b. The level should be kept in its box except when it is being used.
- c. The level should be screwed firmly and with care when fastening it to the tripod.
- d. The level and tripod should be carried on the shoulder except when walking through brush, then it should be carried under the arm.
- e. The moving parts should never be forced.
- f. The leveling screws should be snug against the leveling plate.
- g. The lens on some levels should be protected from the direct rays of the sun by using a sun shade.
- h. The lens should be cleaned with a soft cloth or tissue.
- i. The lens should not be removed from the telescope.
- j. The tripod nuts should be loosened before picking the instrument up or setting it down.

3. Checking and Adjusting the Level

A vocational agriculture student should become familiar with the different parts before using the level. These are shown in the following transparencies.

Transparencies Nos. 1a and 1b

The following procedure should be used in setting up the level:

- a. The tripod legs should be set firmly and at least 3 1/2 feet apart.
- b. The wing nuts should be tightened on the tripod head.
- c. The level should be securely screwed to the tripod head.
- d. One of the tripod legs should be spiked firmly in the ground.
- e. The telescope should be turned over the spiked leg and one of the other legs, and the second leg should be spiked and moved in or out until the bubble is visible in the bubble tube.
- f. The level tube is turned over the third leg, and it is spiked and moved in or out until the bubble is visible in the bubble tube.
- g. The leg nuts should be tightened on the tripod legs.

Before leveling the instrument, the student should place the leveling screws in the mid position in the bosses. This places the center spring under light tension and allows the screws to be raised or lowered as needed. The turret should turn freely.

Leveling the Turret Type Level

The steps in leveling the turret type level are as follows:

- a. The telescope is placed over two of the leveling screws, and the bubble is centered by turning the leveling screws an equal distance in opposite directions. This may be accomplished by moving the thumbs toward or away from each other.
- b. The telescope is set directly over the third screw, and the bubble is centered by turning the third screw.
- c. The leveling process is repeated in each of the above steps until the bubble remains centered in the bubble tube.

Leveling the Utility Type Level

The procedure is as follows:

- a. The telescope is placed over two diagonally opposite leveling screws, and the bubble is centered by turning the screws an equal distance in opposite directions. The thumbs should be moved toward or away from each other.
- b. The telescope is turned over the other two diagonally opposite leveling screws, and the bubble is centered.
- c. The leveling process is repeated in each of the above positions until the bubble remains centered in the bubble tube.

The farm level should be checked for accuracy each time before it is used. The parts that should be checked are the bubble tube, telescope, and cross hairs. The turret type and utility type levels are checked in the same manner.

Bubble Tube - The bubble tube is checked as follows:

- a. The bubble tube is placed over two of the leveling screws, and the screws are turned in or out until the bubble comes exactly between two corresponding vial lines.
- b. Then the turret is swung 180 degrees so that the bubble tube is end for end from the first position. If the bubble does not come exactly to the center between the vial lines as at first, one-half of the amount is corrected by the same two leveling screws. The other half of the difference should be adjusted by the level vial screws shown in the transparency.

The three screws that hold the turret in place should be screwed out to remove the turret and telescope.

Transparency No. 2

The bottom screws on the low end of the tube are loosened and the top screws are tightened. The test and adjustment should be repeated until the bubble stands between the vial lines either way the level vial tube is turned. The bubble tube on the utility level is adjusted with two vial screws shown in transparency.

Telescope - There are two tests that should be conducted on the telescope. One is testing the telescope by inverting the turret, and the other is by testing to see if the line of sight is level when the bubble is centered. The first test is made after the instrument is level by focusing the telescope on a definite spot 200 to 300 feet in the distance with the turret in the correct position. The turret is then inverted and a sight is taken on the spot. If the center of the horizontal cross hair remains on the spot, it is properly adjusted. If the telescope needs adjusting, the small screws at the front (where the telescope goes through the turret) should be adjusted to eliminate half of the error. The process should be repeated until the reading remains the same with the turret in the correct position and in the inverted position.

The second test (a test to see if the telescope is in the line of sight of the level when the bubble is centered) is conducted as follows:

- a. Stakes A and B are driven in the ground 100 feet apart, or some other convenient distance. In the same line but in the opposite direction, Stake C is driven in the ground. The distance between AC and AB should be equal, and the tops of Stakes B and C should be set at the same level.
- b. The instrument is set over Stake A and the rod is held on Stake B. The target should be adjusted so that the horizontal cross hair bisects the target.
- c. The target setting is read and recorded.
- d. The target setting is not changed, and the rod is moved to Stake C.
- e. Stake C is moved up or down until the cross hair bisects the target when the rod is held on Stake C and the bubble is in the center of the tube. If it is necessary to raise the stake, it should be pulled up too far and gradually driven into the ground until it is the correct elevation. The accuracy of the test depends on the stakes being at the same level.
- f. Then the instrument should be moved to within three or four inches of Stake B and leveled.
- g. The rod then is set on top of Stake B, and the target is adjusted until the cross hair bisects the target.

- h. Then the target is left at this setting and carried to Stake C where it is placed on top of Stake C, and a reading is taken. If the cross hair bisects the target, the line of sight is level when the bubble is centered. If the cross hair does not bisect the target, the telescope should be adjusted by the screws at the front of the level frame. The front end of the telescope is raised by unscrewing the bottom screw and tightening the top screw. The telescope is lowered by moving the screws in the opposite direction.

Testing the Cross Hair - The cross hair is tested after the instrument is leveled and the telescope is adjusted, which is accomplished by moving the slide tube in or out until the object comes in focus. The horizontal cross hair is focused on a definite point, and the level is rotated back and forth slightly from side to side. If the ends of the cross hair remain on the point in the same place as the center, the cross hair is in adjustment. If the cross hair is out of adjustment, the instrument should be sent to the company to have it adjusted.

4. Using the Target Rod

Three types of target rods are the Philadelphia, architect's, and self reading rod.

Transparency No. 3

The Philadelphia rod is graduated in feet, tenths, and hundredths and the architect's rod has the same graduations, but is much lighter and shorter. The self-reading rod is graduated in feet, tenths, and hundredths and is used principally for surveying land, running drainage lines, and general soil conservation work.

The Philadelphia and architect's target rod have extensions. The target must be set at the same reading on the face of the rod before it is extended to equal the lowest reading on the back of the extended rod. The target should always represent a true reading and should be raised to the top of the unextended rod section before the rod is lengthened. The target rod has very few parts, but a student should become familiar with the parts and their function if he is to use the rod properly.

The rod is used to measure elevation or comparative heights of objects in their relation to the height of the instrument. For example, a rod reading of three feet at one point and five feet at another point is a difference in elevation of two feet at these two points. Grades are established by moving the target a distance over the ground. The grade is raised when the target is lowered, and the grade is lower when the target is raised.

Instructions to Rodman

To hold the rod, the rodman stands behind the rod and holds it in a vertical position. If the rod is allowed to lean in any direction, the reading will be inaccurate. The rod is usually held by the left hand, and the target is moved by the right hand.

The rodman should place the rod on firm ground before a reading is taken by the man operating the instrument. The rod should not be placed in a depression or on a large clod of dirt to get a reading. In freshly plowed land, the rod should be placed on a footprint that has had a man's weight on it.

When the rodman is too far from the instrument, it is necessary that hand signals be used. The following transparency shows some hand signals that may be used.

Transparency No. 4

Raise the Target - The palm of the right hand is up, and the arm is raised upward.

Lower the Target - The palm of the right hand is down, and the arm is moved downward.

Moving the Rod to the Right or Left - The hand is extended in the direction the rod is to be moved. A long sweeping motion is used to indicate a long distance, while a short quick motion is used to indicate a short distance.

Plumb the Rod (Place the rod in a vertical position) - The arm is extended to full length above head and is moved slowly in the direction required as shown by the vertical cross hair in the telescope.

Hold the Point (used to signal that the level is going to be moved) - Extend the right arm the full length above the head and wave in a circle. The rodman must not move until a backsight has been taken after the level has been set up at another point.

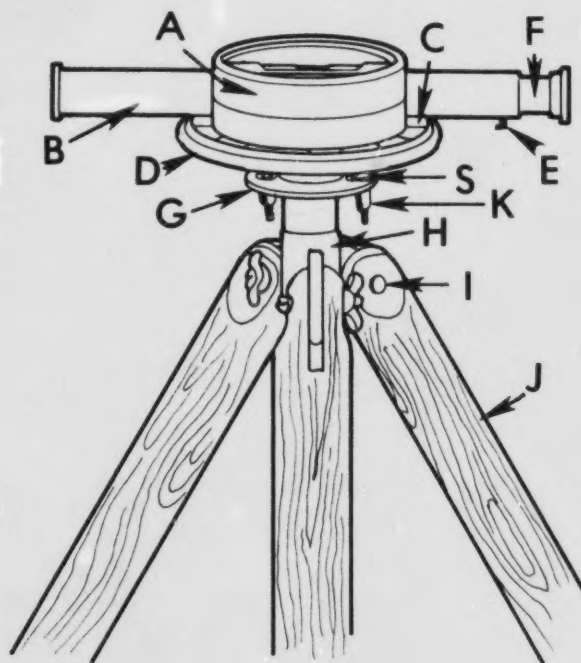
Rodman has Moved the Target - The right arm is extended at a forty-five degree angle from the body, and the palm of the hand is placed on the rodman's head. This signal is used by the rodman.

Observation Completed - Both arms are extended above the head and crossed.

References:

1. Ayres, Quincy Claude, Land Drainage and Reclamation, McGraw-Hill Book Company, Inc., New York.
2. "Farm Surveying", Vocational Agriculture Service, University of Illinois, Urbana, Illinois.
3. Moore, Cairl E., Concrete Form Construction, Delmar Publishers, Albany, New York.
4. Selby, Walter E., "The Farm Level", Kansas State College, Manhattan, Kansas.

PARTS OF FARM LEVELS

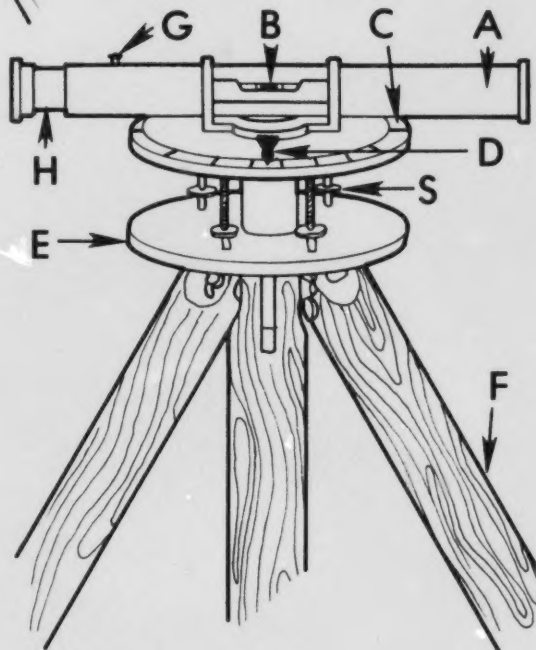


TURRET TYPE

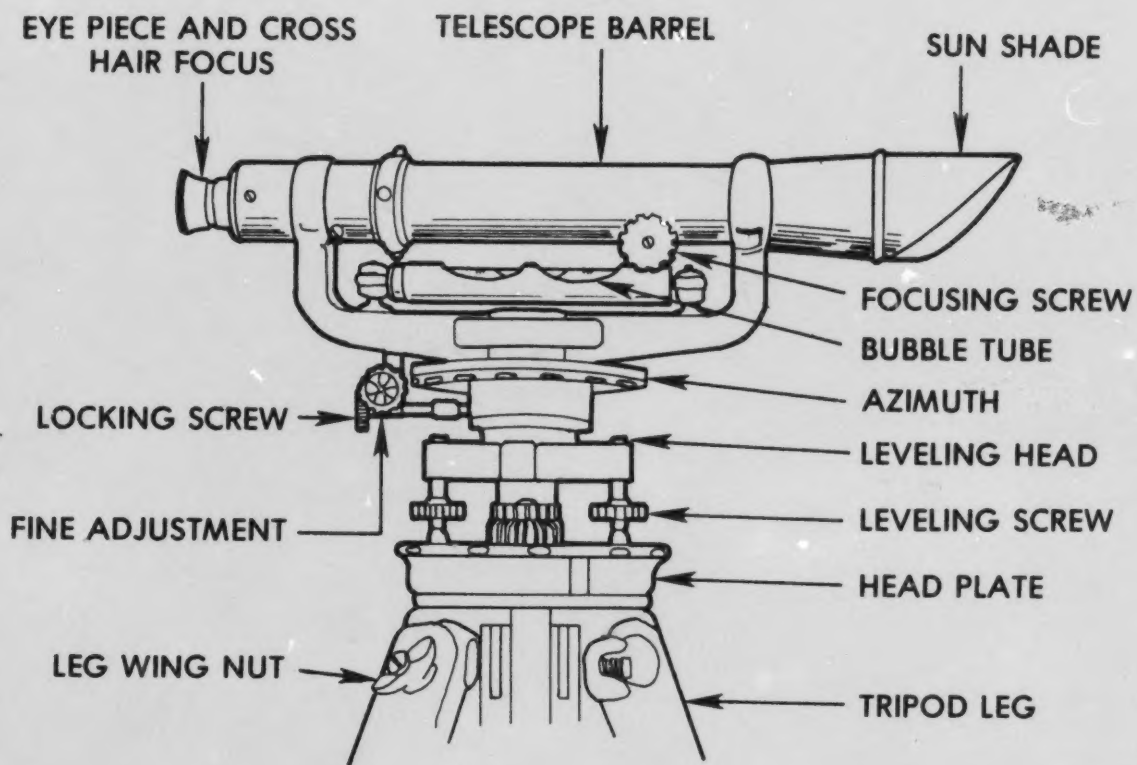
- A - TURRET
- B - TELESCOPE TUBE
- C - GRADUATED CIRCLE
- D - LEVELING PLATE
- E - SLIDE SCREW
- F - SLIDE TUBE
- G - LEVELING HEAD
- H - TRIPOD HEAD
- I - LEG BOLTS
- J - TRIPOD LEGS
- K - BOSS
- S - LEVELING SCREWS

UTILITY TYPE

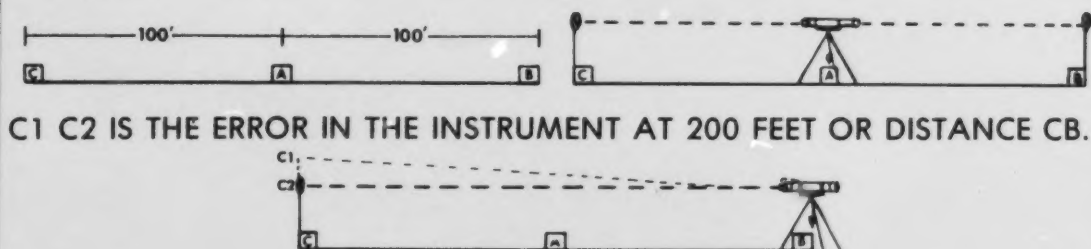
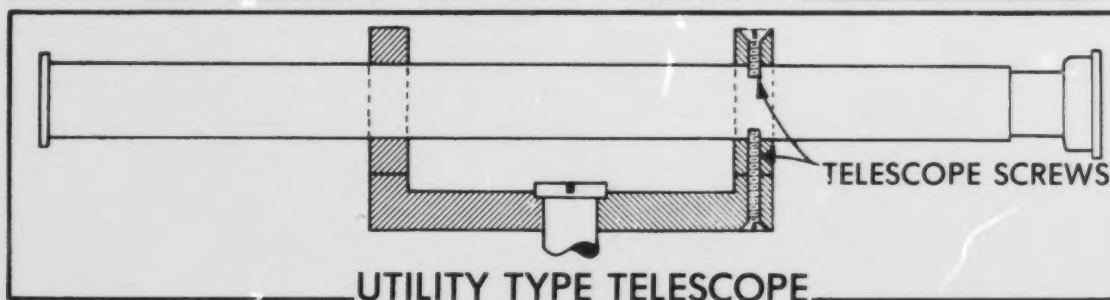
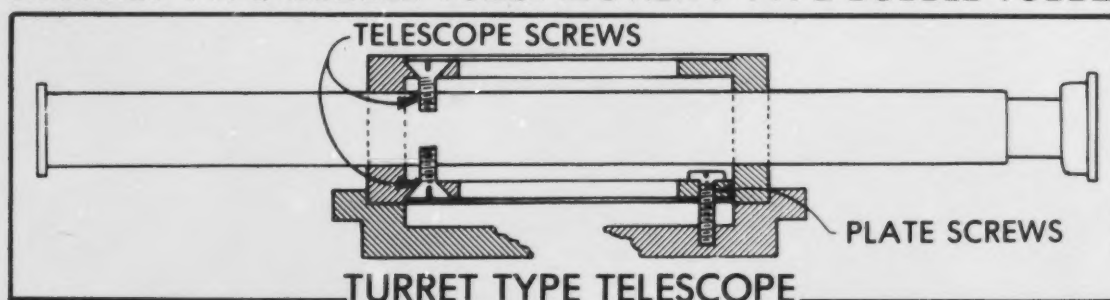
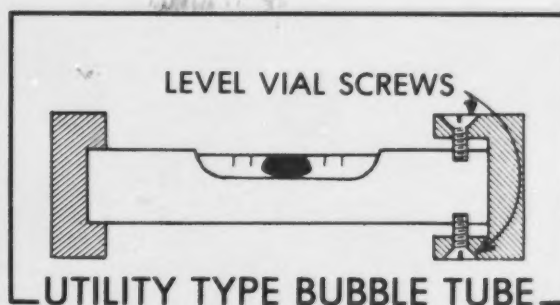
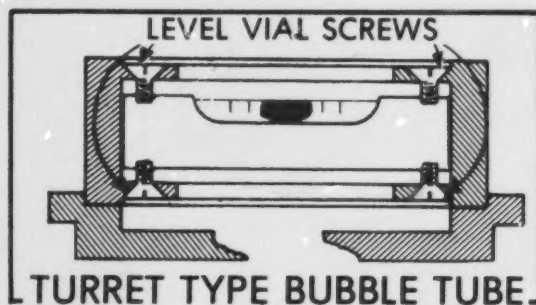
- A - TELESCOPE
- B - LEVEL TUBE
- C - GRADUATED CIRCLE
- D - INDEX ARM
- E - BASE PLATE
- F - TRIPOD LEGS
- G - SLIDE SCREW
- H - SLIDE TUBE
- S - LEVELING SCREWS



PARTS OF A TRIPOD LEVEL



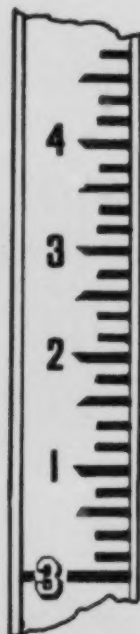
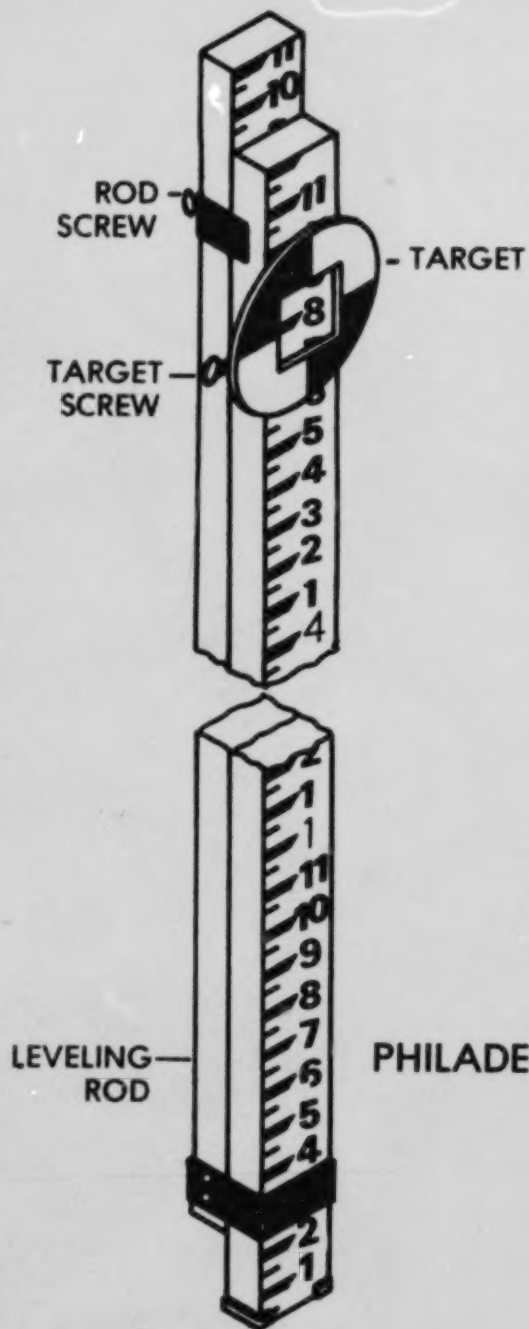
BUBBLE TUBE, TELESCOPE, AND CROSS HAIR



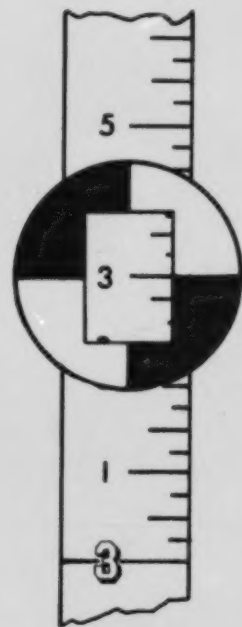
C1 C2 IS THE ERROR IN THE INSTRUMENT AT 200 FEET OR DISTANCE CB.

TESTING THE TELESCOPE TO SEE IF THE TELESCOPE IS IN
THE LINE OF SIGHT OF THE LEVEL

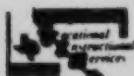
THREE TYPES OF TARGET RODS



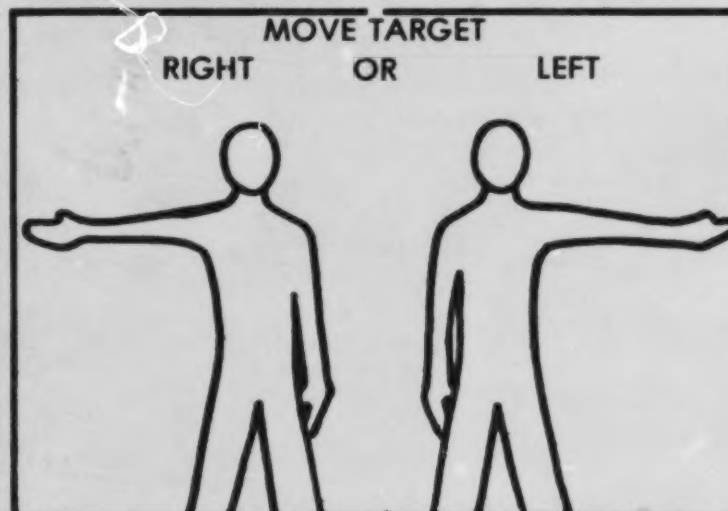
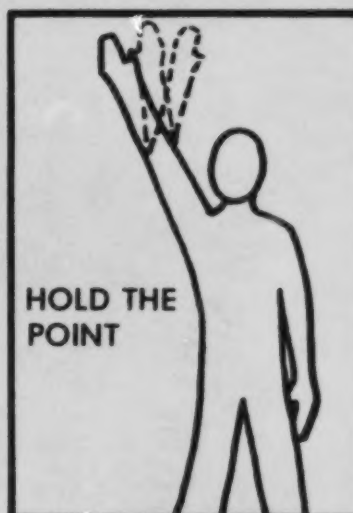
SELF LEVELING



ARCHITECT



HAND SIGNALS USED BY RODMAN



AGRICULTURAL MECHANICS

UNIT E: Farm Level

TOPIC 2: Staking Out Foundations, Differential Leveling, and Staking Out Fence Lines

1. Staking Out Foundations

Because constant improvements are being made in the production and marketing of agricultural products, most farmers sometime in their careers will find it necessary to remodel and enlarge existing farm buildings, build new buildings, or both. To decrease expenses, farmers will build or supervise this construction; therefore, it will be necessary that they understand how a building foundation is staked.

Transparency No. 1

Farm buildings are laid out in many sizes and shapes, but the same basic procedure is used to lay out the foundations on all buildings. Most buildings are rectangular; however, many have projections and re-entrant parts. There are separate procedures for laying out a rectangular foundation and a foundation with projections. Instructions for laying out a rectangular foundation are as follows:

- a. The position of one corner (C) is determined. If the building is to be parallel to a farm road or another building, the farmer will want to measure the same distance back from the road or building in two places (NC and OP).
- b. The level is set up and leveled with the point of the plumb bob over point C, shown in the transparency.
- c. The telescope is sighted at P and clamped in this position.
- d. CD is measured so that it is the desired length of the building.
- e. A stake is set at D in line with the vertical cross hair of the telescope.
- f. The telescope is locked in position after sighting at D, and the graduated circle is turned until one of its zeros coincides with the zero of the vernier.
- g. The telescope is turned 90 degrees and sighted on point F. The distance from C to F is measured to get the desired width of the building.
- h. The instrument is moved to D, and E is set in a similar manner.
- i. The points and measurements are checked for accuracy. The following procedure may be used:
 1. FE and CD should be measured and be the same.
 2. The instrument is moved to E and F, and the angles are checked to see if they are 90 degrees.
 3. The two diagonals CE and FD should be measured. They should be equal.

Some buildings will have projections or re-entrant parts which will make them more difficult to lay out. A foundation of this type is shown in the bottom half of Transparency No. 1. The procedure for laying out the foundation of this type of building is as follows:

- a. The main rectangle should be laid out first and the smaller rectangles laid out afterward in the same manner. If one starts at one corner and continues around the building, errors will accumulate.
- b. The rectangle AKLM should be laid out first.
- c. The small rectangles are then laid out.
- d. The points and measurements, as explained in laying out a rectangular foundation, should be checked on all rectangles or angles.

The batter boards are set up after the foundation is staked.

Transparency No. 2

The procedure to use for setting up batter boards is as follows:

- a. The level is placed in a convenient location.
- b. The height of the masonry is determined. The rod is held on the mark which designates the height of the masonry, and the target is set so it is bisected by the horizontal cross hair of the level. The reading is taken and recorded. This reading will be used on all batter boards.
- c. The batter boards at corner A are located. The board is raised or lowered until the target is in the cross hair.
- d. The height of the batter boards at the other corners is determined in the same manner.
- e. String should be tied to the batter boards so that it will intersect directly over the four corners. The points where the string is attached to the batter boards should be marked. A nail may be driven at this point to hold the string, or a shallow saw cut may be made to hold the string. The string is removed while the foundation is being dug. After the foundation has been dug, the batter boards should be checked to see that they are still level.
- f. The line is established by setting the level over stake A, leveling it, and sighting to stake B. A plumb bob may be used at corners to see if the string intersects the point of each stake.

2. Differential Leveling

Differential leveling is used by a farmer to determine the differences in elevation at different points on his farm. The establishment of the elevation at different points is useful in running drainage lines and building soil conservation structures. These points are referred to as bench marks, after the elevation at different points has been taken and the elevation becomes permanently established.

A bench mark may be a point on a large boulder, concrete slab, or some other permanent point or spot. A bench mark can be established by driving a length of pipe (4 feet is recommended) into the ground within one-half inch of the surface. The purpose of a bench mark is to have a point with a known elevation which can be used as a reference point to determine the elevation of unknown points.

The elevation of a bench mark may be its height above sea level, if this information is known. It is customary in farm surveys to assume the elevation of the first bench mark to be 100 feet and to determine the elevation of all other points in relation to this bench mark.

Transparency No. 3

It is assumed that the elevation at BM-1 in the transparency above is 100.00 feet. The elevation at BM-2 is to be determined. The following procedure can be used:

- a. The instrument is set up at some convenient distance away from BM-1 and in the direction of BM-2. The distance will depend on the accuracy of the instrument and should not exceed 350 feet. If possible the instrument should be located near the center of two readings, BM-1 and TP-1 for example.
- b. A reading is taken and recorded on BM-1. This is 3.02, as shown in transparency. This reading is a backsight (BS), which is a reading taken on a point of known elevation. BS readings are also known as plus sights because they are added to the elevation of the last known point to give the elevation of the line or sight, called height of instrument (HI). The HI at BM-1 is 103.02 ($100.00 + 3.02$).
- c. The next reading is taken at TP-1 where a temporary stake is set. The instrument is not moved to take this reading, which is called a foresight (FS) reading. A FS reading is taken at a point of unknown elevation and is called a minus sight since it is subtracted from the HI to give the elevation at the new point. The elevation or HI at TP-1 in transparency is 99.34 ($103.02 - 3.68$). TP-1 now has a known elevation and can be used when the instrument is moved.
- d. The readings are made as explained above until BM-2 is reached.

The survey should be continued until a circuit is completed, as is shown in Transparency No. 3; and the last FS is taken at BM-1. This is necessary to check the accuracy of the survey.

The final reading in most cases will not be exactly the same as the 100.00 feet which was used at the start. If there is a difference between the original reading and the last reading, this indicates an error. A reasonable allowance can be made for errors. The following formula may be used to determine a reasonable, allowable error:

$$\text{Allowable error} = .014 \text{ times the square root of the length of the traverse in feet divided by } 100.$$

There is also a "rule of thumb" that may be applied to determine allowable error: If the turning point readings are approximately 150 feet in length, the allowable error may be computed by multiplying .01 feet times the number of instrument settings.

Field notes must be kept when differential leveling. Sample field notes made from the readings in Transparency No. 3 are shown in Transparency No. 4a.

Transparency Nos. 4a and 4b

3. Staking Out Fence Lines

702

The best instrument for staking out fences is one that can be moved vertically

as well as horizontally; however, a farm level may be used.

Transparency No. 5

The procedure is the same for a completely new fence line or a new fence line at a right angle to an existing fence. The following procedure may be used:

- a. The instrument is set up with the plumb bob bisecting a corner stake of a completely new fence. The telescope is pointed in the direction of the fence line, and the graduate circle is placed at zero degrees. The stakes are aligned with the vertical cross hair. After the stakes are aligned in one fence line, one would proceed with steps b through d.

If a new fence is being staked out at a right angle to an old fence, a stake in the new fence line is driven three or four feet from the existing fence. Another stake should be driven about twenty feet from the first stake and the same distance from the fence as the first stake. This stake and the stake which the plumb bob bisects are parallel to the fence. The cross hair in the telescope should bisect the second stake. Proceed with steps b through d.

- b. The graduate circle is set at zero.
- c. The telescope is turned until the graduate circle reads 90 degrees and points in the direction of the proposed fence line.
- d. Stakes are set in the new fence line. A tape is used to measure the distance, and the telescope is used to align the stakes.

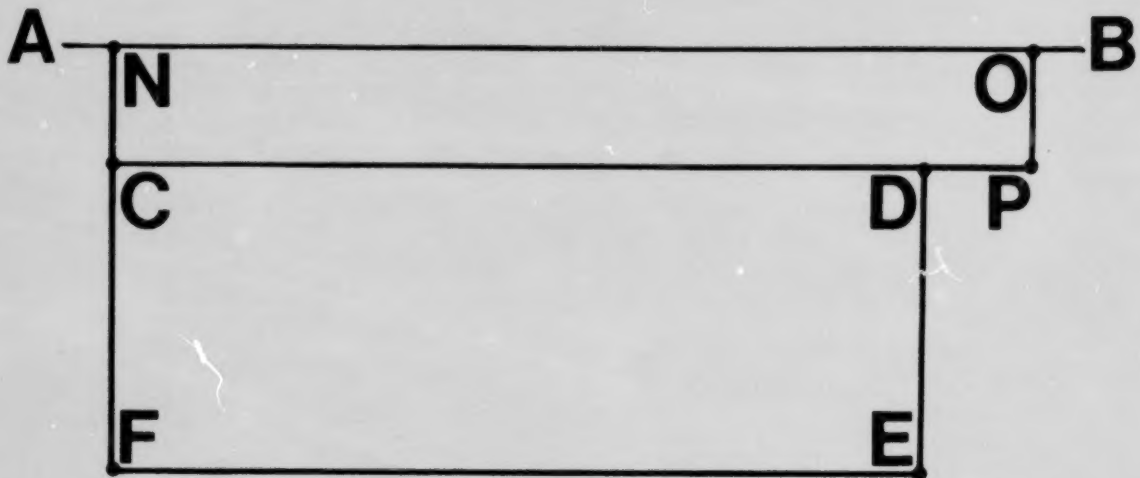
After several stakes have been set, it may be necessary to move the instrument. When the instrument is moved, it should be set over the last stake so that the plumb bob bisects the stake. A backward sight is taken on a stake, and the graduate circle is set at zero degrees. The telescope is then turned 180 degrees. The instrument is prepared for sighting stakes. The same procedure may also be used to align the post after the holes are dug.

References:

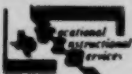
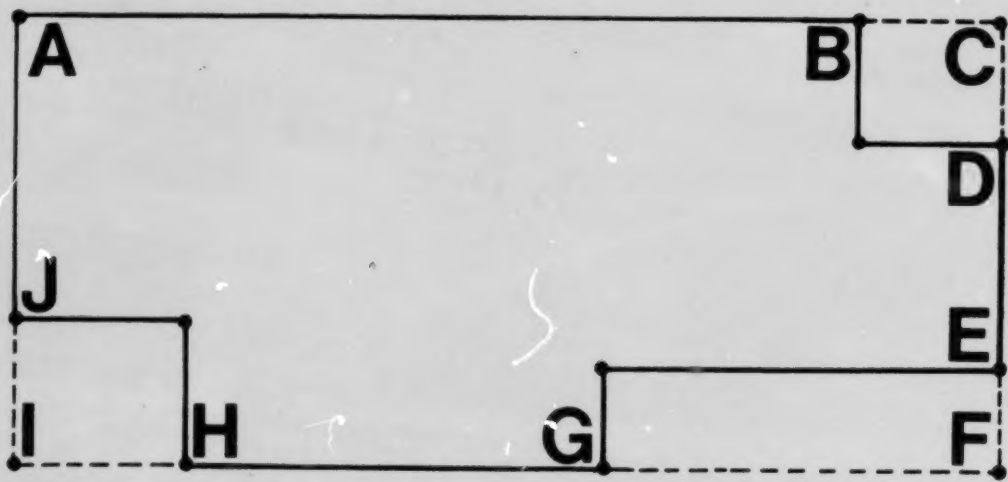
1. Ayres, Quincy C., and Daniels Scoates, Land Drainage and Reclamation, McGraw-Hill Book Company, Inc., New York.
2. "Farm Surveying", Vocational Agriculture Services, University of Illinois, Urbana, IL.
3. "Leveling & Land Measurement Practices for Agriculture, Department of Agricultural Education, University of Arizona, Tucson.

STAKING OUT A BUILDING FOUNDATION

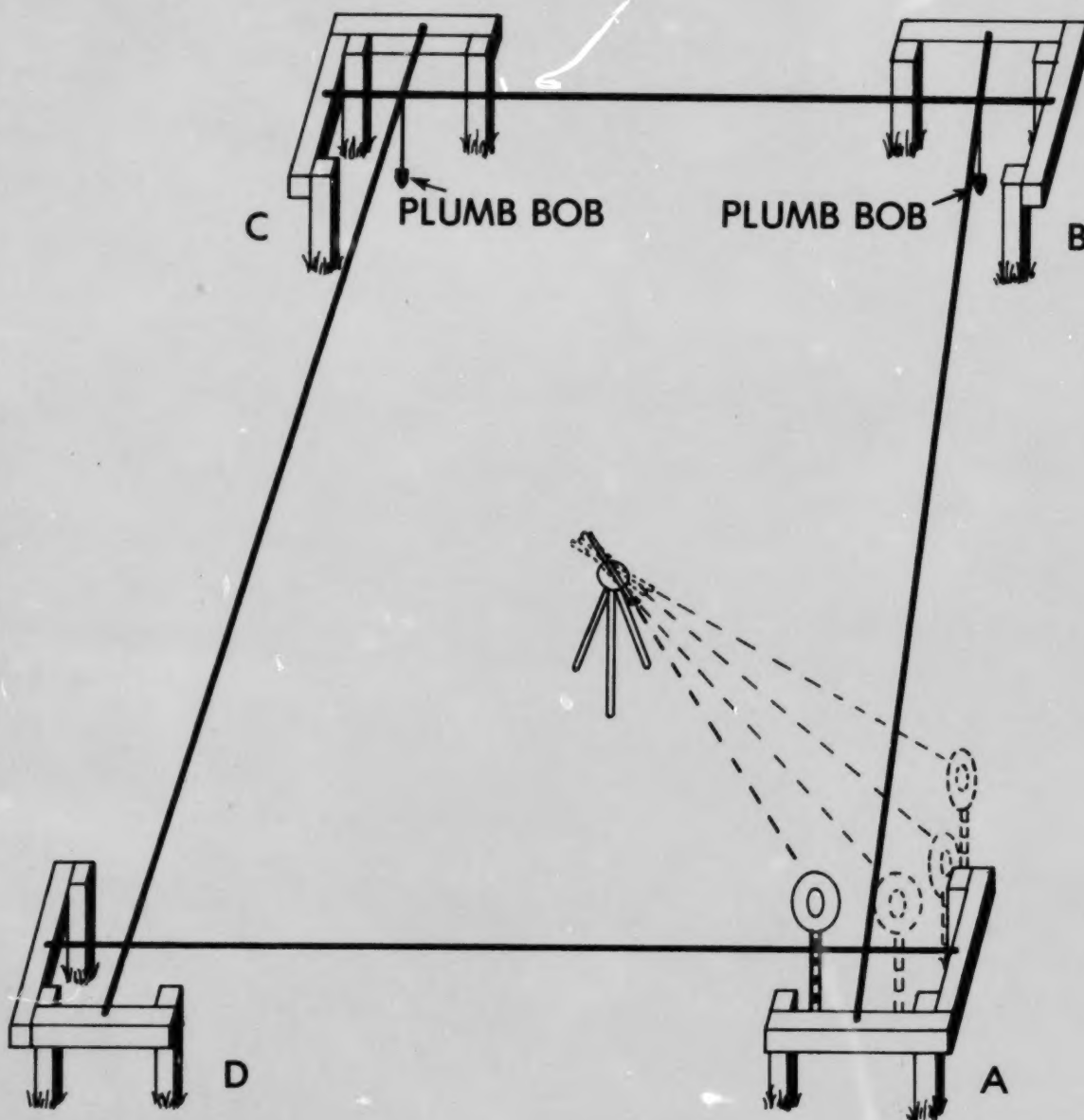
A RECTANGULAR BUILDING



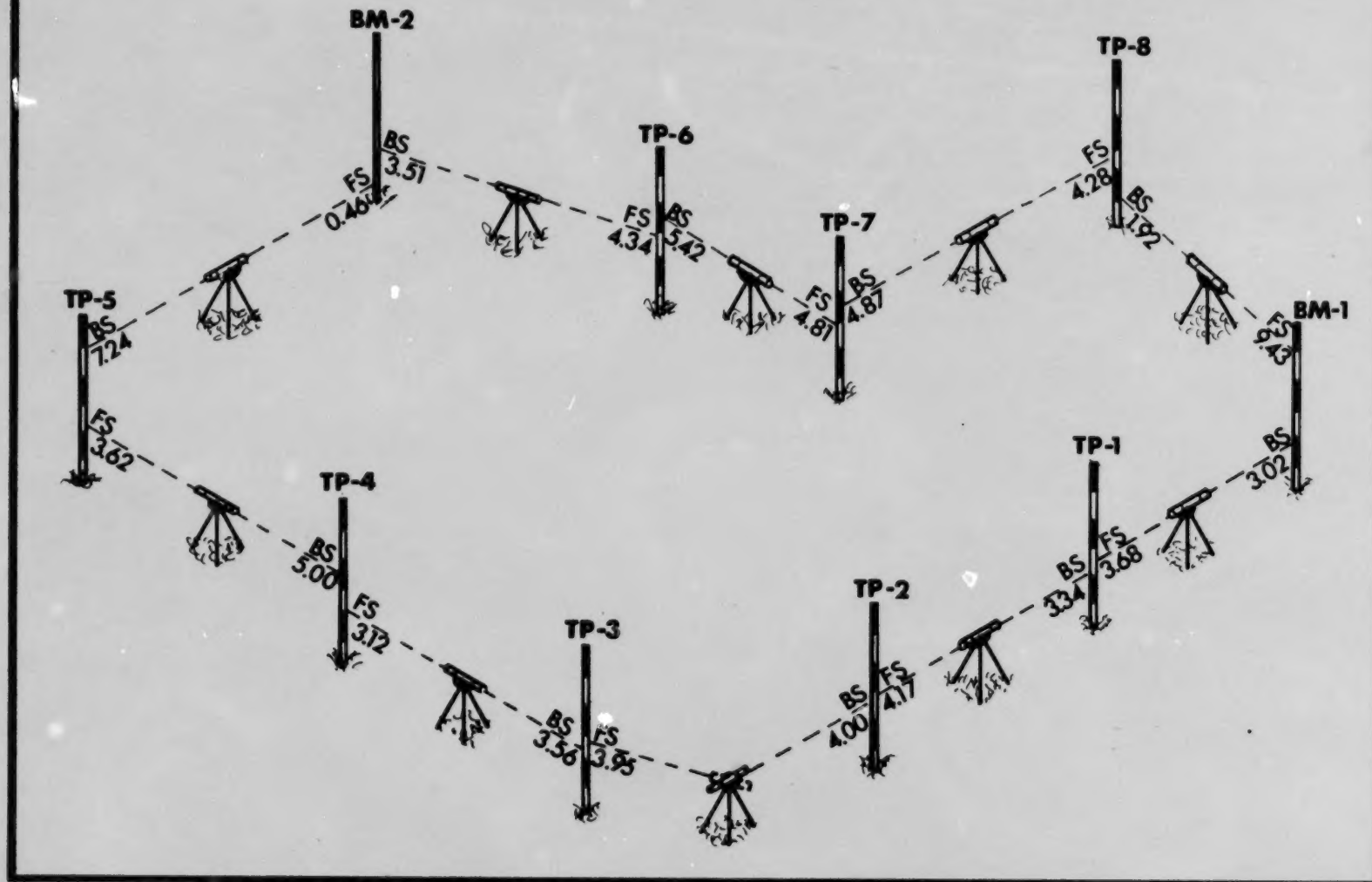
A BUILDING WITH PROJECTIONS OR RE-ENTRANT PARTS



SETTING UP THE BATTER BOARDS

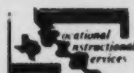


AN EXAMPLE OF DIFFERENTIAL LEVELING



DIFFERENTIAL LEVELING FIELD NOTES

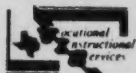
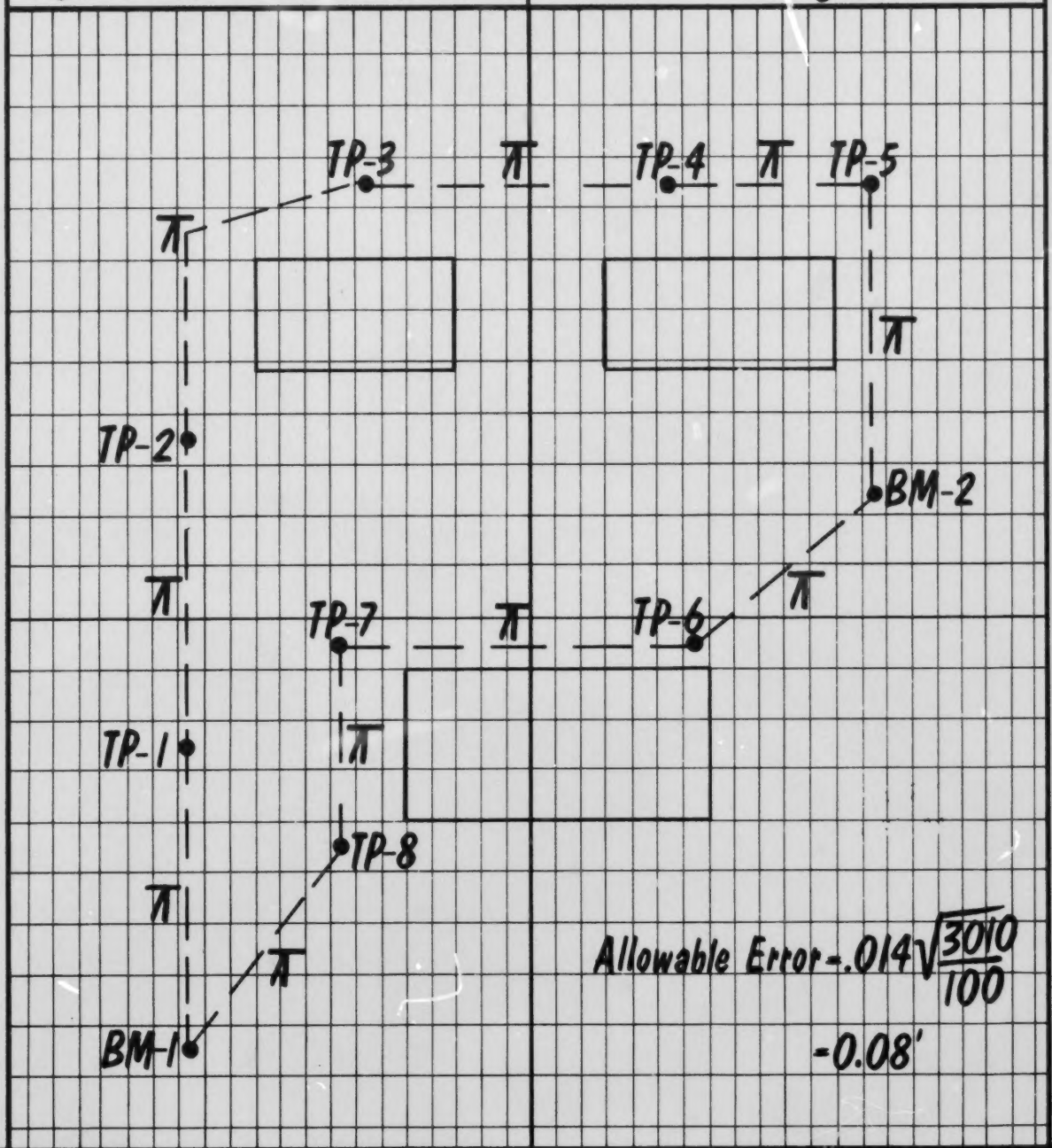
DIFFERENTIAL LEVELING					
<i>Sta.</i>	<i>BS</i>	<i>HI</i>	<i>FS</i>	<i>Elev.</i>	<i>Dist.</i>
BM-1	3.02			100.00	
		103.02			250
TP-1	3.34		3.68	99.34	
		102.68			270
TP-2	4.00		4.17	98.51	
		102.51			330
TP-3	3.56		3.95	98.56	
		102.12			300
TP-4	5.00		3.12	99.00	
		104.00			320
TP-5	7.24		3.62	100.38	
		107.62			370
BM-2	3.51		0.46	107.16	
		110.67			320
TP-6	5.42		4.34	106.33	
		111.75			280
TP-7	4.87		4.81	106.94	
		111.81			310
TP-8	1.92		4.28	107.53	
		109.45			260
BM-1			9.43	100.02	
					3010
		Error = 0.02'			



DIFFERENTIAL LEVELING FIELD NOTES (cont.)

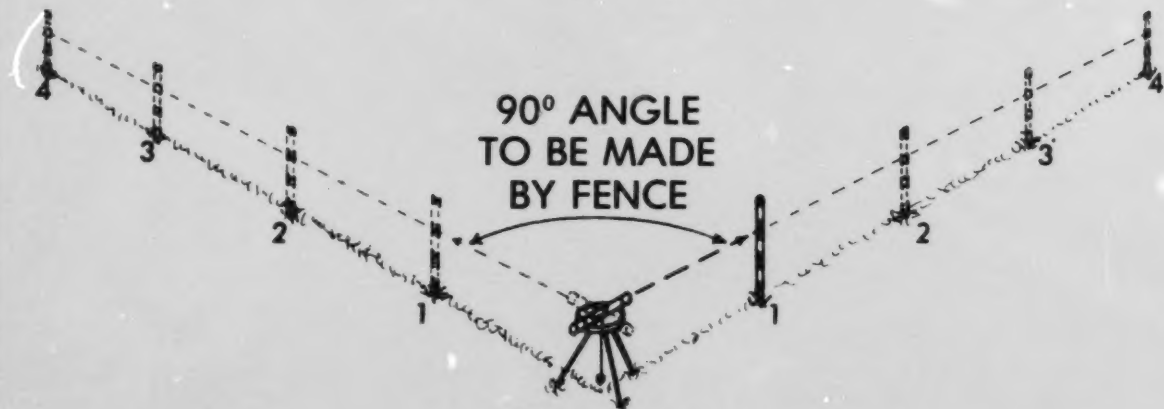
July 22, 1981 clear, warm, calm

Palmer- π Cowling- ϕ

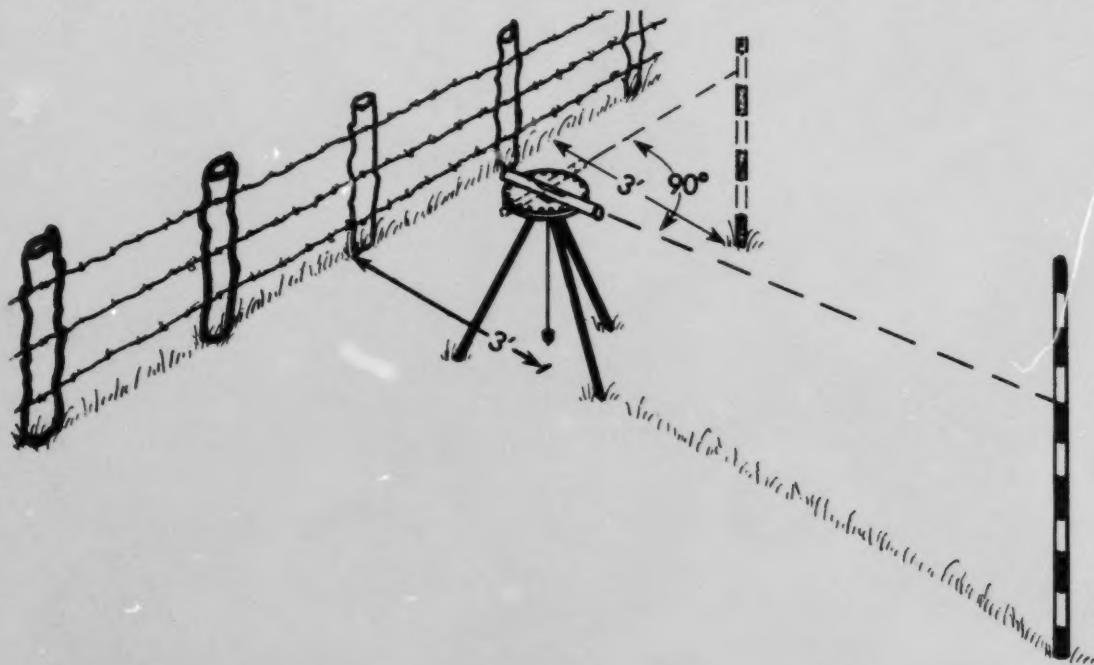


STAKING OUT FENCE LINES

COMPLETELY NEW FENCE



A NEW FENCE AT A RIGHT ANGLE TO AN OLD FENCE



AGRICULTURAL MANAGEMENT

Unit A: Introduction

Topic 1: Importance of Good Management

Note: All terms underlined are included in the "Glossary of Terms."

1. Introduction to Agricultural Management

Agricultural management, being thought of as the adhesive force which binds the farm firm together, is the human element in a farm business which determines the enterprises and production activities included in the farming program. Management includes the initiation of the production processes, making the decisions, and bearing the responsibilities.

Differences in management are easily illustrated because of the wide variation among farms of the same size and type. Management is usually considered to be good when maximum production is secure from the available resources. Failures of farmers and agricultural businesses are due to the lack of objectives or goals more than any other single factor. According to Dun and Bradstreet, 88 percent of all business failures can be attributed to weakness in management. Generally, good management has established goals and objectives as guidelines.

Two elements influence the farmer and his family in establishing goals. These are the production element, the farm business, and the consumption element, the farm household. While one farm family may set their goal to obtain the greatest possible financial returns from their farm, another may place more emphasis on leisure and recreation. The members of the family striving for financial independence are often referred to as being "money hungry", and the members of the family placing emphasis on leisure are often called lazy. Family goals emphasizing neither of the two extremes seem reasonable.

2. Influences on Farm Management

Farm management is usually influenced by the several members which make up the farm family or board of directors, in the case of a farm corporation. In some instances one member of the family or board tends to dominate the decision making. Land, labor, and capital, being limited in quantity, also influence management decisions. Limited capital may prevent the farmer

from buying a new piece of equipment which would make his operation more efficient. Land limitations will influence the farmer's selection of enterprises. For example, a cow-calf beef producer will need more land than a feedlot operator. Labor will influence the farmer in his selection of enterprises. Limited labor will prevent his planting of crops with high labor requirements.

3. Estimating a Manager's Performance

The performance or ability of a farm manager can be estimated in several ways; however, dollar income is the measurement most often used.

Transparency No. 1

According to a recent study conducted in Ohio, the managerial ability of a farmer can be determined by the factors listed in the above transparency. It was also found that the way a farmer spent his time in handling the farm business had more influence on the economic efficiency of the farm than the hours devoted to the farm business.

Agriculture is constantly changing, and it is expected to change even faster. As farming becomes more complex, errors in management will be more costly. Therefore, the need for trained people in agricultural management is greatly increasing.

Reference:

Bryant, W. R. and James E. Hamilton, Profitable Farm Management, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1963.

"Farm Management," Department of Agricultural Economics, Ohio State University.

FACTORS FOR PREDICTING THE MANAGERIAL PERFORMANCE OF FARM MANAGERS

- 1. FAMILY'S DOLLAR INCOME GOAL
(ECONOMIC ORIENTATION)**
- 2. THE DOMINANCE OF THE MANAGER
IN MAKING DECISIONS (DECISIVENESS)**
- 3. MANAGER'S ABILITY TO RECOGNIZE
ALTERNATIVES AND OPPORTUNITIES**
- 4. THE EXTENT OF SOCIAL ACTIVITIES
PARTICIPATED IN BY THE FARM FAMILY**

AGRICULTURAL MANAGEMENT

Unit A: Introduction

Topic 2: Basic Decisions in Agricultural Management

Note: All terms underlined are included in the "Glossary of Terms."

1. Kinds of Decisions in Agriculture

Although decisions in agriculture are of various kinds and may be classified in several ways, the decisions of farm managers usually are in one of two categories, organizational or operational. As the name implies, organizational decisions concern the overall structure of the business.

Transparency No. 1

Both types of decisions affect the success of the farm business. The degree of influence a decision exerts on the business is determined in part by the characteristic of the decision. Five characteristics of a decision are discussed.

Importance - Decisions vary in their importance. The importance of a decision may be determined by measuring the potential loss or gain of the decision involved. An example of the differences in the importance of decisions might be the comparison between the selection of a farming enterprise and the selection of a particular brand of wire to use on a fence. The farmer is justified in spending much more time in selecting an enterprise than in selecting a brand of wire.

Frequency - The frequency in which a decision is made varies considerably. Many farm management decisions when considered separately and infrequently are unimportant, but their importance is much greater when considered frequently and when their cumulative effect is considered. The selection of feed for a group of feedlot cattle may be used as an example. Selecting the feed for this group for one feeding is relatively unimportant; however, the feed selection is very important when selected for a period of one or two months.

Imminence - It is important that some decisions be made immediately, while other decisions may be delayed. The imminence of a decision depends on the cost of waiting. Two decisions with different degrees of imminence are the planting of a crop and the building of a shed. If it is crop planting time, the crop should be planted, as a delay might reduce the yields. Usually, delay in building a barn will have little effect on the overall management decisions or success of a farming operation.

Revocability - Some farm management decisions can be revoked only at tremendous cost to the farmer. Decisions of this nature should be made only after gathering all available information. A flexible farming program usually prevents decisions that cannot be revoked.

Available alternatives - Some situations offer several alternatives. If several alternatives are available, the farmer should eliminate the less likely course of action. The likely choice should be determined and time should be spent securing information that will assist in making a choice. If no alternative is available there is no decision to be made.

2. Factors Available to the Farm Manager in Making Decisions

There are several factors that the farm manager can use in making good decisions; however, first the reasoning process must be learned. Reasoning is usually deductive, which is defined as an act of taking away. Using this process and known information, a person arrives at a tentative conclusion. After arriving at a tentative conclusion, information is collected to test the conclusion or idea. This is known as inductive reasoning. Inductive reasoning may be defined as reasoning built upon general principles acquired from the interpretations of a number of similar situations. Both deductive and inductive reasoning are used in arriving at a conclusion. Using a systematic process in thinking will usually increase one's effectiveness in decision making.

The use of economic principles (supply, demand, and economic conditions) is a factor which may be used effectively in decision making. These principles, which are available on most phases of agriculture for a number of years, will assist one in determining the type of information to collect.

Another factor, farm records (farm budget, production costs, and yields) should be accurately kept so that they can be analyzed and used in making farm management decisions. A comparison to the costs of different enterprises prior to initiating an enterprise may be helpful in making a decision.

The above factors will aid one in making good decisions. The following factors influence a farmer's decisions:

- | | |
|---------------------------|------------------------|
| 1. Friends and relatives | 6. Supply and demand |
| 2. Government regulations | 7. Age of farm manager |
| 3. Weather conditions | 8. Risk involved |
| 4. Market and price level | 9. Available resources |
| 5. Finances | |

3. Steps in Decision Making

Agreeing that decisions based on factual information will increase managerial ability, the manager must determine the process to be used for making better decisions. The following eight steps should be helpful in developing a process.

Transparency No. 2

- (1) The management process begins with a problem, situation, or an established goal. The goal may relate to either of the previously discussed elements, production or consumption.
- (2) All the available facts and information must be gathered for an accurate analysis of the problem.
- (3) An analysis of all resources, both human and material, should be made. Human resources are labor, time, skills, and interest; while material resources are land, equipment, and capital.
- (4) Determine the different ways (establish routes) in which the problem or goal can be successfully accomplished.
- (5) Make a decision as to the route(s) that will be taken.
- (6) Follow through with your decision by putting the plan into action. If the plan is not completed, the efforts of planning will be fruitless.
- (7) Once the decision is made, the manager must assume the responsibility for it.
- (8) Evaluate the results. Were intended goals accomplished? Could a better route have been selected?

4. Management, a Continuous Process

Managing the agricultural business is a continuous and changing process, caused by price fluctuations, natural changes, new farming methods, and changes in the people and institutions with which agricultural managers deal. Even farming programs developed with the aid of extensive planning require constant, day-to-day decisions. Many of the farm manager's decisions in the day-to-day operation of the farm must be made with incomplete knowledge and information.

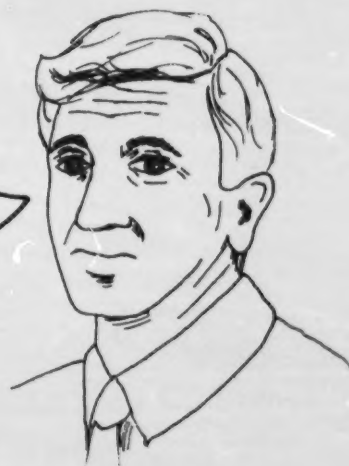
KINDS OF AGRICULTURAL DECISIONS

ORGANIZATIONAL DECISIONS

Should 500 acres be rented, or should 300 acres be purchased?

Should the farm be operated as a partnership or corporation?

What lender is the best source of borrowed capital?



OPERATIONAL DECISIONS

Should cattle be sold this week or next?

Should 250 or 400 pounds of fertilizer be applied to a certain field?

When should the planting of milo commence?



EIGHT STEPS IN DECISION MAKING



AGRICULTURAL MANAGEMENT

Unit B: Principles of Economics

Topic 1: Supply and Demand

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedure and Activities:

To demonstrate the effects of supply, demand, and prices, the teacher may wish to bring one Coke to class and announce that it will be sold to the highest bidder for consumption in class. After the Coke has been sold and drunk, the teacher should bring in enough Cokes for each person in the class and announce that they will be sold in the same manner as the first. Be sure that the class is aware that there are enough Cokes for each member in the class.

1. Determining the Price of a Product

Prices received for farm products, as well as most everything else that is bought and sold in the county, are determined by three price-making factors: (1) the supply of the commodity, (2) the demand for the commodity, and (3) the general price level. No one factor can be used consistently to explain price change. For example, suppose that one is in the beef business and he sold a 450-pound calf for 90¢ per pound; and at another time he sold a 450-pound calf for 50¢ per pound. Why was the price received for the calves different? There are several possible explanations: the supply of calves available for market may have changed drastically, the demand for beef could have changed, or the general price level, which is affected by wars, depressions, periods of recovery, and other factors, could have changed.

2. Supply and Basic Factors that Influence Supply

The quantity of a product such as milk, corn, or cotton that is available to buyers at a given time is called "supply".

The producer has control over some of the factors such as rate of fertilization, selection of seed and land, cultural practices, and insect and disease control that influence yields per acre. A big factor over which the producer has no control is the weather. If the rain does not come at the proper time or the crop is not irrigated at the proper time, the yield per acre will be reduced; therefore, the supply will be reduced for that particular year. In the case of livestock, the number of head of livestock available for market makes up the bulk of the supply for any given year. This is usually influenced by the price. Credit may also influence supply, as credit permits faster expansion.

3. Demand and Factors that Influence Demand

Demand may be defined as the quantity of a commodity or service that buyers will purchase at varying prices under certain conditions at a given time and place.

Transparency No. 1

The quantity that a buyer is willing to purchase varies with the quantity available and the price. Desire and willingness to purchase, ability to purchase, and usefulness of additional units affect the law of demand.

Several factors may influence or change the demand for an agricultural product. Some of these factors which may influence demand are a change or increase in purchasing power, a change in tastes and preferences, competitiveness of substitutes, and population growth.

An example of how a change or increase in purchasing power may influence demand might be illustrated by comparing the consumption of beef in 1950, which was 63.4 lbs. per capita, with the consumption in 1977, which was 125.9 lbs. per capita. As employment, total wages, and salaries increase and as long as wages increase faster than the price of beef, the consumption increases.

A change in tastes and preferences can be illustrated by comparing the consumption of pork over a period of years. The per capita consumption of pork has decreased from 69.2 lbs. per capita in 1950 to 56.9 lbs. per capita in 1977.

Because of the competitiveness of oleomargine, it has replaced much of the butter consumption in the U.S.

As the population of the U.S. grows, there will be an increase in the demand for food.

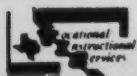
Many other factors and combinations of factors influence the demand for agricultural products. The above examples were given to illustrate the effects of different factors on demand, and these factors may or may not have had a direct influence on the demand of the products mentioned.

References:

1. Hamilton, J. D., and W. R. Bryant, Profitable Farm Management, Prentice-Hall, Inc., Englewood Cliffs, New Jersey.
2. Chastain, E. D., and others, Farm Business Management, Auburn Printing Company, Auburn, Alabama, 1962.
3. "Handbook of Agricultural Charts," U. S. Department of Agriculture, Washington, D. C., 1966.

A HYPOTHETICAL DEMAND SCHEDULE

PRICE PER POUND	POUNDS PURCHASED
\$ 1.50	150
1.30	225
1.20	300
1.00	400
.75	800
.50	1200
.25	3000



Agricultural Management

Unit B: Principles of Economics

Topic 2: Diminishing Returns

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

In order for students to acquire an understanding of the principle of diminishing returns, they should understand the meaning of the following terms: diminishing, diminishing physical returns, diminishing economic returns, factors of production, fixed input, fixed resources, gross income, input, marginal, marginal cost, MC=MR, net returns, output, production costs, profit, and total cost. These terms are defined in the "Glossary of Terms."

1. Diminishing Returns

The term diminishing returns is often used in a conversation on agricultural economics but is very seldom completely understood. An understanding of the law of diminishing returns can be extremely helpful to the farm manager in decision-making.

The principle of diminishing returns has two parts, physical returns and economic returns. The explanation of physical returns will be given first.

Diminishing Physical Returns

The eating of ice cream is one of the examples used to illustrate diminishing physical returns.

Transparency No. 1

As the transparency is being viewed by the students, the teacher should ask the following questions to stimulate student thinking:

1. How many have eaten ice cream?
2. How much can you eat?
3. How many bites does it take to get filled?
4. Which bite tasted best - the last one or the first one?
5. Is there a point where additional bites would make you feel uncomfortable?

Each bite of ice cream represents an additional unit of input, and each bite

helped satisfy a part of the person's hunger. The added amount of satisfaction of the person's hunger diminishes as he nears the full mark (diminishing physical returns), and at a certain point the amount of hunger satisfied becomes negative with each additional bite.

An example related to agricultural management and decision-making is the determination of the amount of nitrogen that should be applied to a corn crop.

Transparency No. 2

From observing the above transparency, one will notice that the application of additional units of nitrogen (input) will increase the yields (output). Other observations that should be made are that the addition of the first unit of nitrogen produced the greatest increase in yields, and the rate of increase in yields diminished as more units of input were added. The most difficult decision to be made by the farm manager is the number of units of nitrogen to apply. Using the above transparency as a basis for determination, how many units should be applied to an acre of corn if all other inputs remain constant? The pounds of nitrogen that should be applied in this example is 240 pounds.

In the above examples, only one variable is given; however, when two or more variables are considered, the determination of the level of resources would be made in the same manner.

Other ways to determine the point of diminishing physical returns are to provide the students with research data of the Texas Agricultural Experiment Stations and have them to construct bar graphs similar to the graphs in transparency No. 1. The graphs should be helpful to the students in selecting the point of diminishing physical returns.

Diminishing Economic Returns

This principle should be much easier for the students to understand after they have a thorough understanding of diminishing physical returns.

In the above discussion the amount of nitrogen to apply to corn was determined. The purpose of the discussion in this area is to determine the most profitable level of nitrogen to apply.

Questions to stimulate student thinking in this area are as follows:

1. Should the goals of the producer be to make maximum yields or maximum profit?
2. Can the profit from corn be increased by increasing yields? How?

Transparency No. 3

An analysis of the table in example No. 1, transparency No. 3, reveals that the addition of 60 pounds of nitrogen cost \$16, and the added return above the cost of the nitrogen is \$83. The addition of another 60 pounds of nitrogen gives added returns of \$74. It becomes unprofitable to add more than 240 pounds of nitrogen to corn. Also, one will notice that maximum yields (173 bu.) did not provide the greatest net returns.

The following conclusions should be made from the above example:

1. Values in terms of dollars and cents can be applied to the diminishing returns principle giving profitability of a variable input;
2. Additional units of input diminish in profitability to a point where they become unprofitable;
3. The point where a variable input (cost) is no longer profitable is when it equals marginal returns ($MC=MR$); and
4. The addition of units of input beyond the point where they equal units of returns is unprofitable.

The above conclusions may also be reached by the students in example No. 2. The following questions should be asked of the students:

1. Is the total returns from an application of \$24 of fertilizer as great as the marginal returns from an application of \$9 of fertilizer? Why? (Yes; the total return in terms of dollar yield is greater.)
2. Are the marginal returns from \$24 of fertilizer as great as the marginal returns from \$9 of fertilizer? Why? (No; the marginal returns declined with additional applications.)
3. Which input, land or fertilizer, varied on the chart in example 2? (Fertilizer)
4. Which inputs were held constant? (Land, labor, and all other inputs.)
5. At what level should fertilizer be applied to give the greatest economic returns? (At the \$24 level.)

The following conclusions should be reached after viewing the chart in example 2 of the above transparency and discussing the above questions:

1. The returns (output) per added unit of fertilizer (input) decline after a stage of rapid increasing returns;
2. Adding dollars worth of fertilizer increases the total returns, although the amount of marginal (additional) increase from each application of input becomes smaller;
3. Additional returns or marginal returns is the amount added to the total return by the "pouring in" of one more unit of input;
4. When all resources except fertilizer were fixed (held constant), each added unit of fertilizer resulted in an increase in returns up to a certain point;

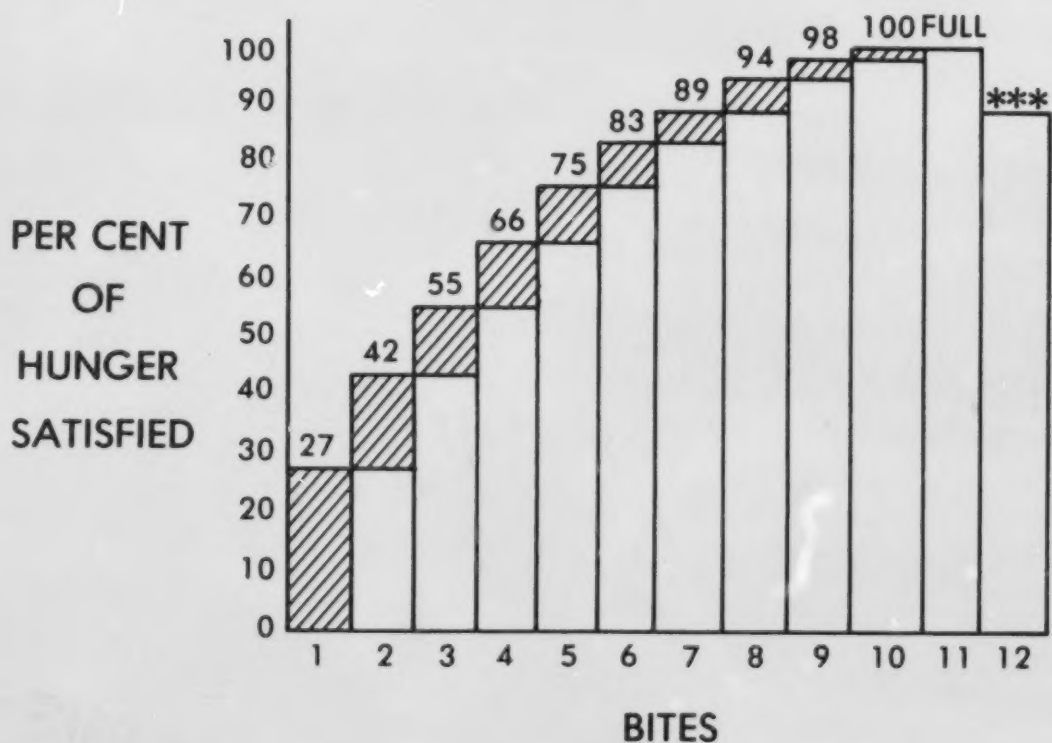
5. Total return is the output resulting from the sum of the units of input; and
6. A diminishing rate of marginal return takes place before a maximum profit is realized.

Other examples could be given to illustrate diminishing physical returns. However, after a discussion of the examples given, students should be able to draw the conclusion that by attaching cost and price to the physical inputs and outputs the principle of diminishing returns becomes useful in decision-making. The student should also understand that to obtain the most profitable returns production must be increased until marginal cost equals marginal returns ($MC=MR$).

References:

1. Becker, Manning H. and Emery N. Castle, Farm Business Management, The Macmillan Company, New York, 1962.
2. Robertson, Lynn S., Farm Management, J. B. Lippincott Company, New York, 1958.
3. "Profit-Maximizing Principles," Department of Agricultural Education, Ohio State University, Columbus, Ohio, 1970.

SATISFACTION FROM EATING ICE CREAM



— AMOUNT OF SATISFACTION ADDED BY EACH BITE.

— NEGATIVE SATISFACTION.

EFFECT OF NITROGEN ON CORN YIELDS*

Lbs. NITROGEN APPLIED	BUSHEL - YIELD
0	67
60	103
120	133
180	154
240	173
300	169

* Hypothetical and not based on research in Texas.

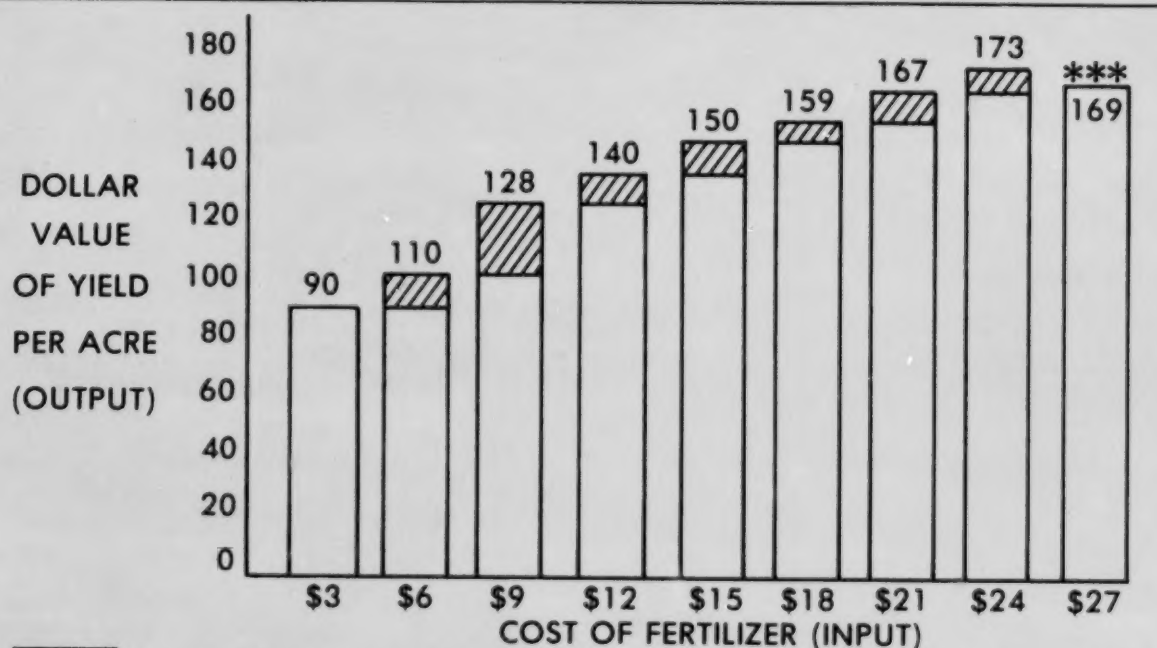
Example 1

EFFECT OF NITROGEN ON CORN *

NITROGEN APPLIED	YIELD	ADDED YIELD	NITROGEN COST @26¢/lb.	ADDED YIELD @\$3.00/bu.	ADDED RETURN ABOVE N COST
0	67 bu.	0 bu.	\$-0-	\$-0-	---
60	103	36	16	36	\$83
120	133	30	16	30	74
180	154	21	16	21	47
240	173	19	16	19	41
300	169	-10	16	-10	-46

Example 2

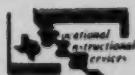
RESPONSE FROM FERTILIZER *



AMOUNT OF ADDITIONAL OUTPUT ADDED BY EACH SUCCESSIVE UNIT OF INPUT.

NEGATIVE MARGINAL RETURNS.

* HYPOTHETICAL DATA



AGRICULTURAL MANAGEMENT

Unit B: Principles of Economics

Topic 3: Comparative Advantage and Enterprise Relationships

Note: All terms underlined are included in the "Glossary of Terms."

1. Comparative Advantage

The United States has nine major farming areas which have developed over a period of years because of changes in demand, profits, production, and other factors. Within each of these regions, a variety of crops is grown, and different kinds of livestock are raised. However, each farm within an area has similar enterprises and systems of production. The reason for the similarity in farming programs is the farmers have found it to their advantage, comparative advantage, to follow this program.

Comparative advantage, as applied to agriculture, is the placing of emphasis and efforts in the area where the most returns will be received. An understanding of comparative advantage will assist the farm manager in making management decisions. Also, the farm manager should be aware that certain factors can influence his efforts and turn them into advantages or disadvantages.

Transparency No. 1

Comparative advantage may be illustrated in several ways. A recent example has been the change in livestock production in New York State. At one time most of the farms in New York raised sheep. Today, these farms are producing milk. Because of the demand for milk in New York, it has become advantageous for the farmers to produce milk. Another example is given in the following transparency.

Transparency No. 2

The comparison of the production of corn and oats on two farms can be used as an example of comparative advantage. As you can see, farm number

two is more efficient in the production of corn than is farm number one, and farm number one is more efficient in the production of oats than is farm number two. It would be to the farmer's advantage to grow corn on farm number two and oats on farm number one.

In the above example, only one physical factor, the soil, affected production. Other physical factors affecting the production of agricultural products are climate, topography, and distance. In addition, biological factors such as insects, diseases, and weeds influence the production of a crop in an area.

References:

1. Becker, Manning H. and Emery N. Castle, Farm Business Management, The Macmillan Company, New York, 1962.
2. Hall, I. F. and W. P. Mortenson, The Farm Management Handbook, The Interstate Printers and Publishers, Danville, Illinois, 1960.

INFLUENTIAL FACTORS: COMPARATIVE ADVANTAGE

MARKETS



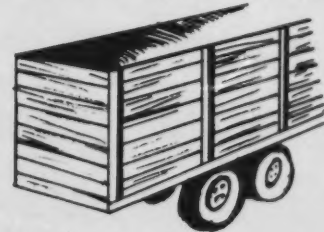
CLIMATE



SOILS AND TOPOGRAPHY



FREIGHT RATES



LABOR SUPPLY



INSECTS AND DISEASES



SANITARY REGULATIONS

CHANGING CUSTOMS

AN EXAMPLE OF COMPARATIVE ADVANTAGE



FARM 1

FARM 2

	FARM 1	FARM 2
Corn	40 bushels	55 bushels
Oats	35 bushels	25 bushels
Total	75 bushels	80 bushels

AGRICULTURAL MANAGEMENT

Unit B: Principles of Economics

Topic 4: Resource Substitution

Note: All terms underlined are included in the "Glossary of Terms."

1. Substitution of Agricultural Resources

A knowledge of the principle of resource substitution can be applied to many of the problems confronted by the agricultural manager. To apply the principle, the manager, receiving the same results, substitutes one resource or item for another. It is often possible in agricultural production to substitute a cheaper item for a more expensive one.

Transparency No. 1

For example, it may be possible to substitute barley for corn, as has been done in the transparency, in a ration making the ration cheaper and without affecting total production. Barley is much cheaper than corn when they are selling at the prices quoted in the transparency. For them to be of equal feeding value for dairy cattle, barley should sell for \$2.25 per cwt. when corn is selling for \$2.50 per cwt.

If it is possible to maintain quality and yields, it is economical to substitute one item of production for another if the cost of the first is less than the cost of the second.

The application of the principle of resource substitution is not limited to the feeding of livestock and can be used in many agricultural situations. How many possible applications of resource substitutions can you list?

AN EXAMPLE OF RESOURCE SUBSTITUTION

A CONCENTRATE MIXTURE FOR DAIRY CATTLE:

Ground corn
substituted for corn - Ground barley 1,130 lbs.

Ground oats 500 lbs.

Wheat bran 200 lbs.

Linseed Meal 150 lbs.

Salt 20 lbs.

2,000 lbs.

Corn cost per cwt. \$2.50

Barley cost per cwt. \$2.05

AGRICULTURE MANAGEMENT

Unit C: Agricultural Finance

Topic 1: Importance and Uses of Credit

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedure and Activities:

The teacher may wish to have the students complete a cash flow projection and other instruments for their productive enterprises, although some of the items listed will not apply.

1. Financial Management

Management of finances is the most important function of the farm manager. Farmers and ranchers, possessing a great deal of technical knowledge and "know how," cannot be successful unless they are competent money managers. Careful planning of finances is probably more important than planning other aspects of the farm. Some very good farmers and ranchers have taken bankruptcy because of their inability to manage money.

2. Agricultural Credit

At one time the farmer who sought credit was considered to be a poor manager. This is no longer true. The manager approaching a lending institution to negotiate for credit should not do so in an apologetic manner, for the lending institution must sell its commodity, money or credit, in order to stay in business. The use of credit, however, is a privilege which must not be abused. The reputation as a poor credit risk is a difficult one to overcome.

The salary of management in the competitive American system is directly related to the amount of capital invested. In the business of farming, the farm operator is the manager. Earnings vary with the amount of capital invested. The formula, capital + labor + management = profits, applies to all types of business, farming included. Each of the resources in the formula, however, must be in the right combination to provide maximum profits.

Transparency No. 1

The use of credit by farmers and ranchers has increased rapidly in the last few years. Higher production costs and an increase in size of operations has caused farmers to borrow more money. Farm debt has increased 372 percent

during the period of 1960 to 1978 and has continued to increase annually since the end of the period.

It is interesting to note that during the period of debt increases the farm population decreased 50 percent. Fewer farmers are borrowing more money. Credit is viewed by wise managers as a resource of the farm business. As a resource, credit must be managed and increased in value (power to sell more debt).

3. Types of Credit

Transparency No. 2

Credit is generally required to increase the size of the farm business. The size of a farm business can be increased in two ways: (1) by physically increasing the farm by purchasing or renting more land (requires real estate capital), and (2) by increasing the efficiency and productive capacity of the existing farm (requires non-real estate capital).

Non-real estate capital is divided into working capital and operating capital. Working capital is money spent to purchase productive inputs that are used for more than one year. Breeding stock, equipment, and machinery are examples. Money invested in feed, fertilizer, and labor (rapidly consumed in the productive process) is considered to be operating capital.

Managers must decide which type(s) of investments will return the most profit to the business. Once the decision has been made, the appropriate type of loan must be secured.

4. Classification of Credit

Transparency No. 3

Credit is classified according to its period of use. The classifications are long-term loans, intermediate loans, and short-term loans.

Long-term loans are used to purchase land and buildings. The loan period ranges from eight to 40 years. Interest rates for this type of loan are usually lower than for the other types. A mortgage on real estate normally is used as collateral for long-term loans. Loans of this type are made by the Federal Land Banks, Farmers Home Administration, insurance companies, local banks, and individuals. A high percentage of the loans on agricultural land are made by the individuals selling the land.

Intermediate loans are for a period of one to seven years. Capital investments are usually made with the money from this type of loan. Examples are breeding stock, tractors, and other equipment. Production Credit Associations, Farmers Home Administration, local banks, finance companies, and individuals are sources of this type of credit.

Short-term loans are for a period of one year or less. They are often referred to as production loans and are used to purchase fertilizer, seeds, fuel, and to pay rental on land. Some producers are able to borrow short-term money without security. This is particularly true with farmers having a good reputation. Money borrowed without security is referred to as a signature loan. The borrower signs a promissory note that the loan will be paid on or before a specified date. Production Credit Associations and local banks are sources of short-term loans. It is not uncommon for local businesses to carry their customers for purchases of this type.

5. Kinds of Credit

Transparency No. 4

The two kinds of credit are productive credit and consumption credit.

Productive credit is used to increase production or income and is justifiable when the estimated increase in production will increase profits. Production credit is used to purchase livestock, land, equipment, storage facilities, seed, fertilizer, and labor.

Consumption credit, consumer credit, is used to purchase consumable items used by the farm family and does not contribute to the farm income. It is relatively easy for a family to abuse the use of consumption credit. It is also possible for the family through the use of consumption credit to limit the amount of productive credit available.

Installment loans are a form of consumer credit used by many farm families. To cover the cost of keeping records, losses, and risks, businesses charge a higher interest rate on installment loans than on other kinds of loans.

Another form of consumer credit, which is growing in popularity and use, is credit card purchases. The interest on extended credit card purchases is comparable to that of installment loans. A credit card purchase paid in thirty days is interest free. Statutes require firms charging interest on credit card purchases to publish their interest rates.

6. Need for Capital

The decision to borrow money to expand the farm business should never be taken lightly. An unwise decision could lead to the reputation as a poor credit risk. Such a reputation is difficult to overcome. Facts should serve as the basis for deciding whether to borrow. Facts may be obtained from records of past performance and projections of planned changes.

Transparency No. 5

Partial budget (enterprise budget), cash flow projection, family living budget, pro-forma financial statement, and pro-forma income statement are tools used to evaluate the proposed change. These may be referred to as forward planning tools. Managers use them in making decisions as to whether to expand the farm business. If after completing the above instruments, it appears that expansion would be unprofitable the manager should not attempt to borrow money.

Lenders use the forward planning tools in the evaluation of loan applications. Borrowers are often able to secure loans because they have prepared the tools and have adequate information. Each of the forward planning tools are important and related to each other. Managers should be familiar with their uses.

Transparency No. 6

Most managers constantly are seeking ways to increase profits. Often new ideas are given a mental examination before preparing a written budget. If an idea appears to have merit, then a partial budget is prepared.

Information for the budget is secured from past farm records and projections. The above transparency is an example of a budget and shows expenses and income from 100 acres of grain sorghum. The manager has the opportunity of renting an additional 100 acres for the cash rent of \$25 per acre. With the exception of a combine and truck, other equipment is available. Combining and hauling can be acquired at a reasonable price in the manager's opinion. The budget indicates a net return of \$2627.10.

Charts Nos. 1a and 1b

Information for the cash flow statement is taken from farm records and the budget of proposed changes. Crop income is derived in July and August from the sale of grain sorghum. Rental expense is shown in the month of February. Fertilizer, herbicides, and application expenses are shown in March and April, while cost of seed is shown in April. Other entries are taken from past records and are adjusted for anticipated price increases or decreases.

Transparency No. 7

As the name implies, the cash flow projection is an estimate of the timing and amount of income and expenses. The cash flow graph illustrates graphically when management will need to borrow money. Whenever expenses are greater than income, money must be borrowed. The graph shows that expenses will be greater than income in January, February, March, April, June, July, October, November, and December. Figures used in preparing the graph may be found on lines 12 and 37 of the cash flow projection.

It is important to remember that the cash flow projection is a plan. Emergencies or opportunities may arise that cause changes to be made in planned expenses and income. A good manager can adapt to these changes with little difficulty.

Also, one should be reminded that the cash flow projection does not indicate the profitability of an operation, but rather the possibility of meeting financial obligations. Ability to repay the loan is of principal importance to the lender, thus the lender is extremely interested in the cash flow projection. Often the lender will ask the borrower to develop a cash flow projection before making the loan.

Chart No. 2

An important part of the cash flow projection is family living expenses. A family living budget is very important in developing the overall farming plan, as these expenses must be paid out of farm income. Groceries, utilities, educational expenses, clothing, family automobile, vacation, furniture, and other items are included in this area.

Transparency No. 8

The pro-forma financial statement is a statement of the net worth position of the farm if everything occurs as planned. It shows the change in net worth due to planned changes. Information for preparing the pro-forma financial statement is secured from inventory records and the cash flow projection.

Transparency No. 9

Questions concerning the profitability of planned changes can be answered by reviewing the pro-forma income statement. Information from the cash flow projection and inventory records is compiled to show farm profits.

It is important to note that past records serve as a basis in forward planning. Complete, accurate, and useful records are an extremely important part of financial management. Memory cannot be depended upon for an accurate source of farm information.

References:

1. Hopkins, John A., Peter J. Berry, and C. B. Baker, Financial Management in Agriculture, The Interstate Printers and Publishers, Inc., Danville, Illinois, 1973.
2. Chastain, E. D. Jr., and others, Farm Business Management, Auburn Printing Company, Auburn, Alabama, 1962.
3. Bryant, W. R. and James E. Hamilton, Profitable Farm Management, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1963.

Cash Flow Projection

	TOTAL	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
OPERATING SALES													
1 LIVESTOCK	27600					27600							
2 LIVESTOCK PRODUCTS													
3 CROPS	21150		1400				9250	2625	7375		500		
4 OTHER FARM INCOME	15800						100			15600	100		
5 TOTAL OPERATING SALES	64550		1400			27600	9350	2625	7375	15600	600		
CAPITAL SALES													
6 LIVESTOCK	2000				2000								
7 MACHINERY & EQUIPMENT													
8 TOTAL CAPITAL SALES	2000				2000								
NON-FARM INCOME													
9 NON-FARM WAGES													
10 OTHER													
11 TOTAL NON-FARM INCOME													
12 TOTAL INCOME (5+8+11)	66550		1400		2000	27600	9350	2625	7375	15600	600		
OPERATING EXPENSES													
13 FEEDER LIVESTK. PUR.													
14 FEED PURCHASE	6000	2000	1000								500	1000	1500
15 LIVESTK. EXP. (VET., ETC.)	200			100			100						
16 SEED & PLANT PUR.	902				902								
17 FERT. & OTHER CROP SUP.	6825			2475	1700		750		600	1300			
18 GAS., FUEL, OIL	2800			400	400	400	400	400	400	400			
19 REPAIRS	2450			600	600				500	250	250	250	
20 HIRED LABOR	3050			250				700	700	700	700		
21 PROPERTY TAXES	4800				2400							2400	
22 INSUR. (FIRE, LIAB., ETC.)	750		750										
23 AUTO & TRK. (FARM SHARE)	900	75	75	75	75	75	75	75	75	75	75	75	75
24 UTILITIES (FARM SHARE)	600	50	50	50	50	50	50	50	50	50	50	50	50
25 RENT	7500		2500				5000						
26 OTHER FARM EXPENSES	300	25	25	25	25	25	25	25	25	25	25	25	25
27 CUSTOM HIRE	1140								1140				
28 TOTAL OPERATING EXP.	38217	2150	4400	3975	6152	550	6400	1250	3490	2800	1600	3800	1650

V. A. III

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Chart No. 1a

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Continued

CAPITAL EXPENDITURES

	TOTAL	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
29 LIVESTOCK	800												800
30 MACHINERY	20000						20000						
31 BUILDINGS, FENCE, ETC.													
32 TOTAL CAPITAL EXPENDITURE	20800						20000						800

OTHER EXPENDITURES

33 FAMILY LIVING, INVST., NON-FARM	8019	575	582	560	1585	675	650	555	515	525	528	624	635
34 PAYT. PREV. COMMITMENTS - PRIN.	15000	4000				4500		4000	2500				
35 PAYT. PREV. COMMITMENTS - INT.	4000					200		3400	400				
36 TOTAL OTHER EXPENDITURES	27019	4575	582	560	1585	5375	650	7955	3415	525	528	624	635
37 CASH OUTFLOW (28+32+36)	86036	6725	4992	4535	7737	5925	27050	9205	6905	3325	2128	4424	3085

FLOW OF FUNDS SUMMARY

38 CASH BALANCE - BEGINNING	500	500	775	1183	648	911	1227	527	947	1417	1452	924	500
39 SOURCE OF DOLLARS (LINE 12)	66550		1400		2000	27600	9350	2625	7375	15600	600		
40 USE OF DOLLARS (LINE 37)	86036	6725	4992	4535	7737	5925	27050	9205	6905	3325	2128	4424	3085
41 CASH DIFFERENCE (38+39-40)		-6225	-2817	-3352	-5069	22586	-16473	-6053	-1417	13692	-76	-3600	-2585
42 MONEY BORROWED THIS YEAR	53000	7000	4000	4000	6000		17000	7000			1000	4000	3000
43 PAYT. ON CUR. LOAN - PRIN.	33000					21000				12000			
44 PAYT. ON CUR. LOAN - INT.	599					359				240			
45 CASH BALANCE ENDING	415	775	1183	648	911	1227	527	947	1417	1752	924	500	415
46 OUTSTANDING ON REAL ESTATE		68000	68000	68000	68000	68000	68000	64000	64000	64000	64000	64000	64000
PREVIOUS DEBT: NON-REAL ESTATE		9500	9500	9500	9500	5000	5000	5000	2500	2500	2500	2500	2500

OTHER

47 OUTSTANDING ON THIS YR.'S DEBT		7000	11000	15000	21000		17000	24000	24000	12000	13000	17000	20000
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V. A. III

VI-C-1
Chart No. 1b

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Family Living Budget

	Total	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1 FOOD	1440	120	120	120	120	120	120	120	120	120	120	120	120
2 HOUSEHOLD OPERATING EXP.	1320	110	110	110	110	110	110	110	110	110	110	110	110
3 HOUSEHOLD EQUIP. & FURNISH.	500					300			100		100		
4 HOUSE REPAIRS & RENT	300		150									150	
5 CLOTHING	960	65		185		50		200	30	120	50	100	160
6 ENTERTAINMENT & RECREATION	490	20	20	20	20	20	220	20	20	20	20	20	70
7 EDUCATION AND READING	110		20					30		20			40
8 MED. EXP. (INCL. HEALTH INS.)	580	40	40	90	40	40	40	40	40	90	40	40	40
9 CHURCH AND WELFARE	240	60			60				60				60
10 GIFTS OUTSIDE HOME	104		45							10		49	
11 OTHER	525	35	87	35	35	35	35	35	35	35	88	35	35
12 LIFE INSURANCE	250	125					125						
13 ADD. TO SAVINGS & INVST.													
14 INCOME TAX & SOC. SEC.	1200				1200								
15 NONFARM BUSINESS EXPENSES													
16 TOTAL FAMILY LIVING & NONFARM BUSINESS EXP. *	8019	575	592	560	1585	675	650	555	515	525	528	624	635

* Appears on line 33 of Cash Flow Projection

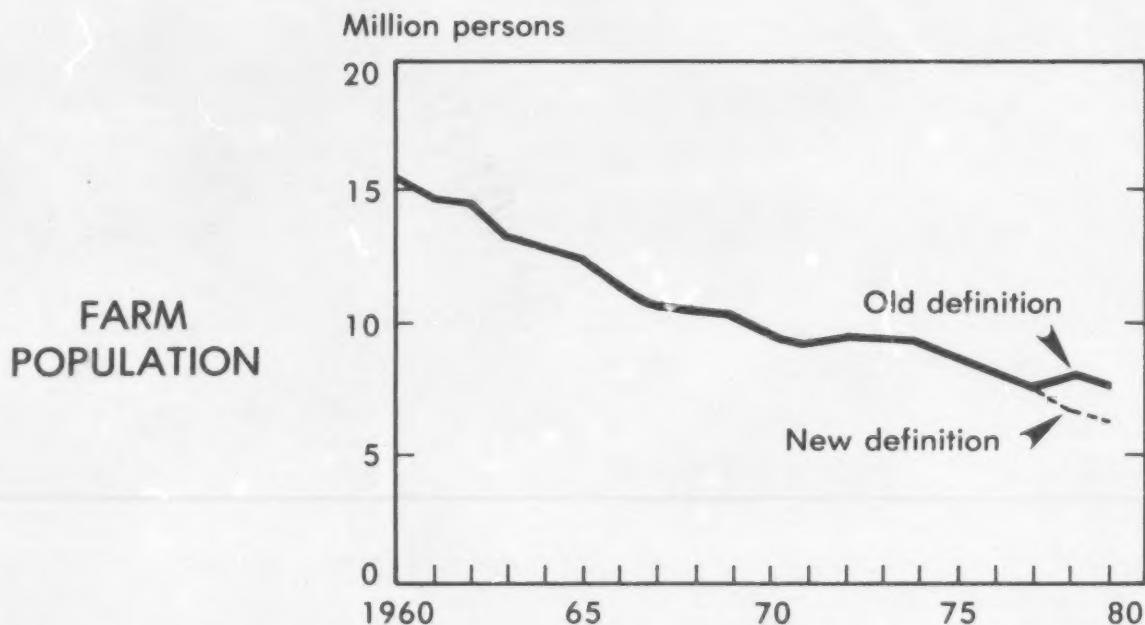
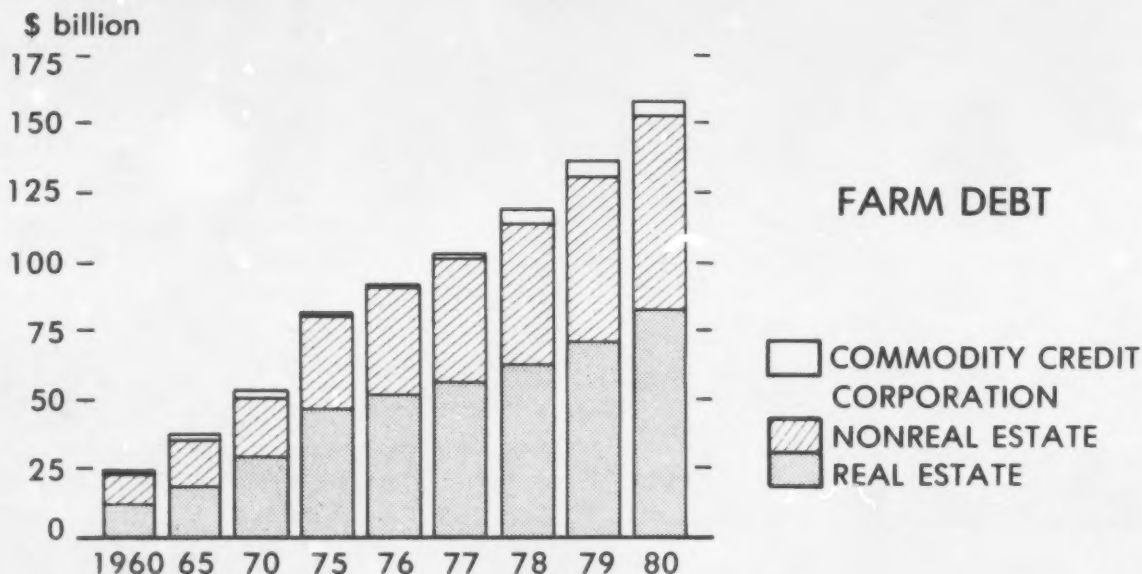
V. A. III

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Chart No. 2

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TOTAL FARM DEBT AND FARM POPULATION



\$ TYPES OF CAPITAL \$

REAL ESTATE



NON-REAL ESTATE

Working Capital



Operating Capital



CLASSIFICATION OF CREDIT

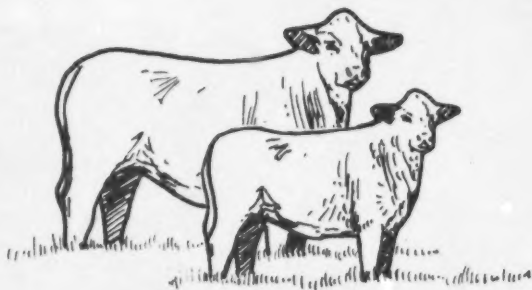
LONG TERM LOANS - Used to purchase land and buildings, and are for a period of eight to forty years.

INTERMEDIATE TERM LOANS - Extend for a period of one to five years for the purchase of breeding livestock, farm equipment, tractors, and similar items.

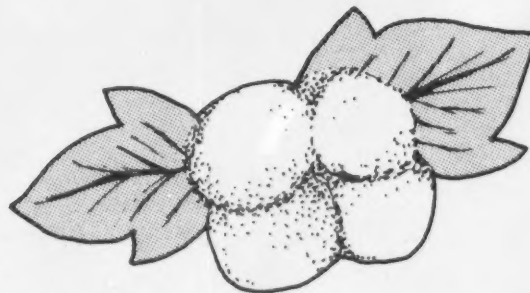
SHORT TERM LOANS - Usually written for a period of one year or less to cover the cost of feeder livestock, feed, fertilizer, seed, fuel, etc.

KINDS OF CREDIT

PRODUCTIVE CREDIT

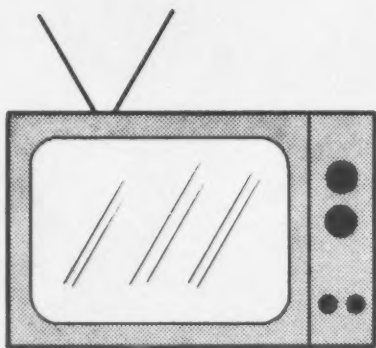


Cattle

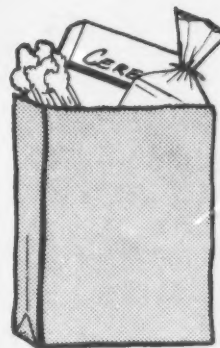


Cotton

CONSUMPTIVE CREDIT



Television



Groceries

TOOLS FOR FORWARD PLANNING

***Enterprise Budget (Partial Budget)**

***Cash Flow Projection**

***Family Living Budget**

***Pro-Forma Financial Statement**

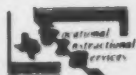
***Pro-Forma Income Statement**

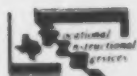
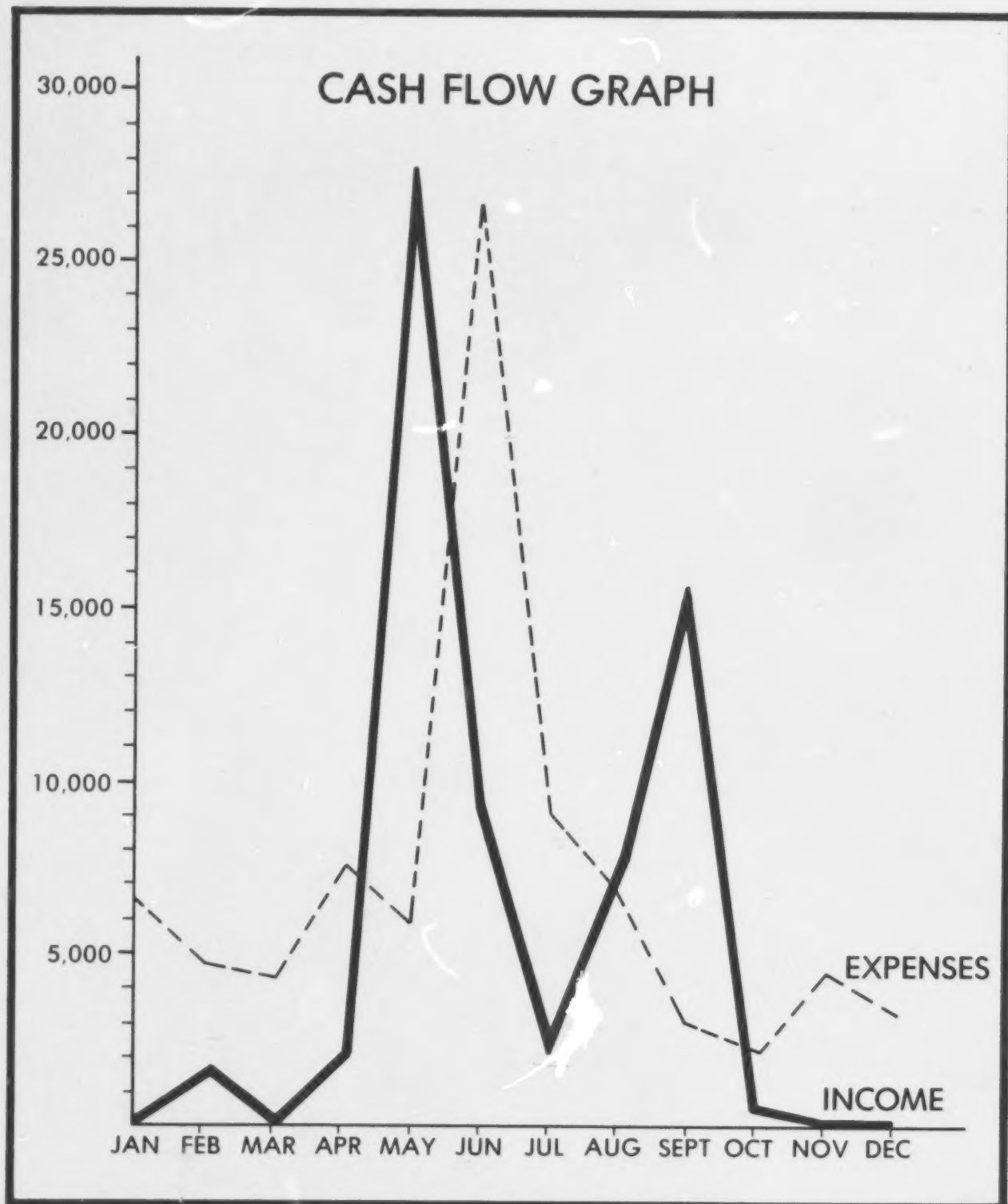


PARTIAL BUDGET

100 Acres of grain sorghum

<u>RECEIPTS</u>	UNIT	PRICE OR	QUANTITY	VALUE OR
GRAIN	CWT.	COST/UNIT		COST
		\$3.00	300,000	\$9,000.00
<u>EXPENSES</u>			TOTAL RECEIPTS	\$9,000.00
Seeds	Lbs.	.10	1,000	\$ 100.00
Fertilizer	Acre	6.95	200	13.90
Fertilizer/App.	Acre	1.25	100	125.00
Herbicide	Acre	2.43	100	243.00
Insecticide/App.	Acre	2.88	100	288.00
Machinery	Acre	2.56	100	256.00
Tractor	Acre	4.97	100	497.00
Labor	Hour	2.50	100	250.00
Rent on land	Acre	25.00	100	2,500.00
Custom combine	Acre	7.50	100	750.00
Custom hauling	Cwt.	.25	300,000	750.00
Interest on money	Dollars	.10	\$6,000.00	600.00
TOTAL EXPENSES				\$6,372.90
NET RETURNS				\$2,627.10





V. A. III

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VI-C-1
No. 7

PRO-FORMA FINANCIAL STATEMENT

CURRENT ASSETS

Cash	\$ 1,157
Livestock Held for Sale	15,600
Crops	3,000
Feed	4,500
Supplies	1,300

TOTAL CURRENT ASSETS \$ 25,557

FIXED ASSETS

Machinery & Equipment

Beg. Inventory	30,000
Plus Purchases	20,000
Less Deprec.	7,250
	<u>\$ 42,750</u>

BREEDING LIVESTOCK

Beg. Inventory	44,800
Plus Purchases	800
Less Sales	2,000
Less Deprec.	800
Plus Livestock Raised	4,350
	<u>\$ 47,150</u>

BUILDINGS

Beg. Inventory	14,000
Less Deprec.	1,000
	<u>\$ 13,000</u>

REAL ESTATE 192,000

TOTAL FIXED ASSETS 294,900

TOTAL ASSETS \$320,457

CURRENT LIABILITIES

Accounts Payable	\$ 20,000
Machinery Note Due	2,500
Current Portion of	
R.E. Debt	4,000
Accrued Payroll Taxes	300

TOTAL CURRENT LIABILITIES \$ 26,800

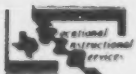
FIXED LIABILITIES

Mortgage (less current portion) \$ 60,000

TOTAL LIABILITIES \$ 86,800

NET WORTH \$233,657

TOTAL LIABILITIES & NET WORTH \$320,457



PRO-FORMA INCOME STATEMENT

OPERATING RECEIPTS

Sale of Crops	\$21,150
Sale of Livestock	27,600
Government Payments	15,600
Other	200
Total Operating Receipts	<u>\$64,550</u>

OPERATING EXPENSES

Feed Purchased	\$ 6,000
Livestock Expenses	200
Seed & Plants Purchased	902
Fertilizer & Chemicals	6,825
Gas, Fuel, & Oil	2,800
Repairs	2,450
Hired Labor	3,050
Property Taxes	4,800
Insurance	750
Auto & Truck	900
Utilities	600
Interest	4,599
Rent	7,500
Other	300
Custom Hire	1,140
Total Operating Expenses	<u>\$42,816</u>

Net Cash Income from Oper.	<u>\$21,734</u>
----------------------------	-----------------

ADJUSTMENT FOR CHANGE IN INVENTORY:

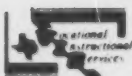
	<u>Feed</u>	<u>Market Livestock</u>	<u>Crops</u>	<u>Supplies</u>	<u>\$</u>
Beg. Inventory	\$4,500	\$13,700	\$3,300	\$1,000	
End. Inventory	4,500	15,600	3,000	1,300	
Net Change (±)		+\$ 1,900	-\$ 300	+\$ 300	+ 1,900

Net Operating Profit \$23,634

ADJUSTMENT FOR CAPITAL ITEMS:

	<u>Machinery & Eqpt.</u>	<u>Improvements</u>	<u>Breeding Livestock</u>	<u>\$</u>
Beg. Inventory	\$30,000	\$14,000	\$44,800	
Plus Purchases	20,000		800	
Less Sales			2,000	
Less End. Inv.	42,750	13,000	47,150	
Net Change (±)	-\$ 7,250	-\$ 1,000	+\$ 3,550	-4,700

Profit (loss) from Operation	\$18,934
Projected Family Expenses	8,019
Retained Farm Earnings	<u>\$10,915</u>



AGRICULTURAL MANAGEMENT

Unit C: Agricultural Finance

Topic 2: Sources of Credit and Interest Rates

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

Since the interest rate is the major expense in borrowing money, the students should be given several problems requiring them to use the different methods of calculating interest.

1. Credit Sources

Because of the many sources of credit available and differences in lending policies of the different sources, a knowledge and understanding of credit and credit practices should be helpful in securing credit. Lenders differ in the interest rates charged, length of loan, and purposes for which money is loaned.

In selecting a lender, it is important to remember that the interest rate is not the most important factor in securing a loan. More important is the lender's willingness to extend a line of credit should an unexpected event occur. Another important factor is the lender's knowledge of the enterprise or farming operation.

An example of the importance of a lender's knowledge is the agricultural representative of The Bank of America, located in Los Angeles, California. Over one-half of the loans made to dairies in a large area of California is made by this representative. Dairymen drive as far as 350 miles, passing many banks along the way, to borrow money from this bank. Because of the representative's knowledge of dairying, he will make loans that other banks turn down.

The following transparencies provide a concept of farm assets and debts and institutions and agencies holding the mortgages for the farm debt. It will also be noticed that some agencies and institutions make only certain kinds of loans. A discussion of some sources of credit is given below.

Transparency Nos. 1a and 1b

Commercial Banks - Based on volume of loans, commercial banks are the most important source of credit. About 25 percent of the total agricultural debt is owed to banks. This percentage represents about 13.5 percent of the real estate loans and 45 percent of the non-real estate loans. Commercial banks lead in loan volume because they make all types of loans.

Individuals - The next most important source of agricultural credit is individuals. About 36 percent of the farm real estate mortgages are held by individuals. Interest rates, tax deferments and reductions, and payment options are some of the reasons individuals are willing to finance real estate.

Dealers and Merchants - Retail merchants and other agricultural businesses are included with individuals and others in the chart on non-real estate debt. Their credit is usually in the form of an open account; however, some cash loans are made. Although interest rates are usually higher from this source, the convenience of this type of credit is the reason for its popularity.

Federal Land Banks - These were created by Congress in 1916 for the purpose of providing long-term credit for agriculture. They are an excellent source of credit because of the favorable interest rates.

There are 12 Federal Land Banks in the United States. A FLB is located in each of the 12 Farm Credit Districts. These banks make loans through more than 500 Federal Land Bank Associations, which are located in all agricultural areas of the country.

Borrowers are required to purchase five percent of their loans in land bank stock from the local association. Thirty-six percent of all farm mortgage loans were made by the associations in 1977. The FLB secures funds through the sale of bonds to individuals and commercial lending institutions.

Production Credit Association - The PCA was established by an Act of Congress in 1933 for the purpose of providing favorable, short-term credit for agriculture. PCA funds are secured from the Federal Intermediate Credit Banks, who in turn secure their money from private lenders. Borrowers must also purchase five percent of their loans in PCA stock. PCA loans are production loans, crops or livestock. In 1977, the PCAs loaned about 25 percent of the non-real estate loans.

Life Insurance Companies - Insurance companies have been excellent sources of credit for financing long-term real estate loans. Loans are made through brokers, correspondents, and company representatives. Insurance companies hold about 15 percent of agricultural real estate mortgages.

Commodity Credit Corporation - Administered as an agency of the USDA, the CCC is a government owned corporation. Loans are made on eligible commodities such as grains, cotton, peanuts, and tobacco. Farmers use the commodities as security for the loan. Payment of loan is made by purchasing the loan or delivering the commodity to the CCC. The CCC made about 10 percent of the non-real estate loans in 1977.

Farmers Home Administration - The FHA was created by the government during the depression of the early thirties to assist tenant farmers in becoming land owners. It provides financing to farmers who are unable to secure credit from any other source. The advantage of borrowing money from the FHA are as follows:

1. A large percent of the total cost of the property can be borrowed;
2. The repayment plan is based on the borrower's ability to repay; and
3. Supervision of the loan and planning assistance are provided.

The FHA secures its funds for loans from congressional appropriations, so the number of loans made is dependent upon Congress. The FHA accounted for seven percent of the farm mortgage loans and about seven percent of non-real estate loans in 1977.

Federal Intermediate Credit Banks - These are usually not a source of credit for farmers, but they do provide funds for PCA and Federal Land Banks. However, there are provisions for the FICB to participate with local PCA in making large loans to agricultural operations.

Small Business Administration - Most SBA agricultural loans have been for related enterprises such as feed mills, hatcheries, and custom feed lots. However, in 1976 Congress passed legislation which permits the SBA to make agricultural production loans. SBA loans have a favorable interest rate.

Transparency No. 2

A review of the above transparency will provide a comparison of the rates of interest of lenders, length of loans, percent of appraisal value that may be loaned, and purposes of loans. All of these factors change because of economic conditions and the money market.

Transparency No. 3

Another aspect of borrowing that farmers may wish to consider is the cash discounts sometimes offered by merchants. A cash discount of three percent can amount to an annual interest rate of 54 percent. The above transparency is an example. Because it is easier to calculate, most lending institutions figure annual interest rates on a 30-day month and 360-day year. Other discount rates may be calculated in the same manner.

2. Cost of Credit

Interest is the major expense in borrowing money. In addition to interest, borrowers are often required to pay commission fees, recording fees, title certification charges, insurance fees, and service charges. A common fee often charged when purchasing a house is referred to as points. A point is

one percent and is charged by the lender for making the loan. The total finance charge (cost of credit) is the sum of all miscellaneous fees plus interest charges.

Transparency No. 4

Formulas for calculating true interest are given in the above transparency. The method used to calculate interest makes a difference in the cost of credit. There are many ways of calculating interest charges. Examples using the formulas in the above transparency are given in the following transparency.

Transparency No. 5

An explanation of each of the three methods is provided below.

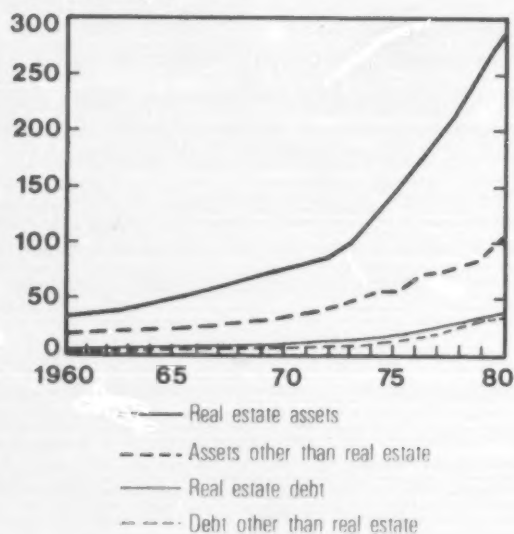
Simple Interest - The full amount of the loan is received by the borrower. At the end of the loan period the full amount of interest and principal are paid. When payments are made several times during the note period, interest is charged on the remaining balance of the principal.

Discount Loan - The interest on this type of loan is subtracted from the principal at the time the loan is made. For example, the borrower would receive only \$900 of a \$1,000 loan if the interest was 10 percent. Since the full amount of the principal is not received, a higher interest rate is paid by the borrower.

Add-On-Loan - This is the method often used for calculating interest on consumer loans. The loan is repaid in installments of equal payments. Interest is added-on at the beginning of the payments. For example, a \$1,000 loan at 10 percent interest would be repaid in monthly installments of \$91.67 (\$1,000 principal + \$100.00 interest = \$1,100 ÷ 12 = 91.67).

THE FARM DEBT

**FARM ASSETS AND DEBTS
PER FARM**
\$THOUS.



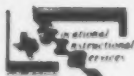
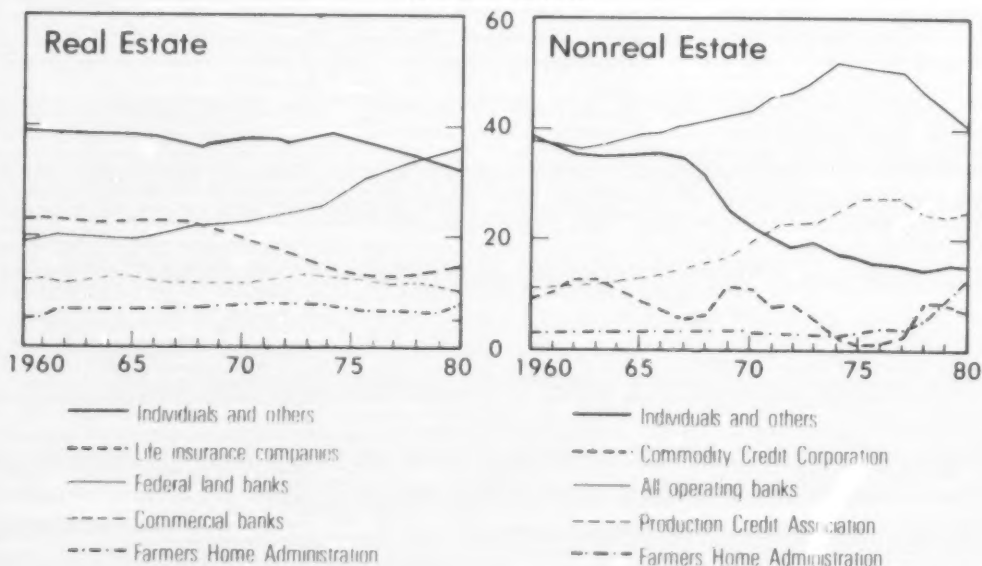
Farm Assets and Debts Per Farm

	1971	1972	1973	1974
	1,000 dollars			
Assets:				
Real estate	76.9	83.8	94.4	117.3
Nonreal estate	35.3	38.9	44.6	53.5
Debts:				
Real estate	10.5	11.3	12.6	14.8
Nonreal estate	8.3	9.4	10.4	11.8

	1975	1976	1977	1978
	1,000 dollars			
Assets:				
Real estate	133.2	152.3	178.8	196.2
Nonreal estate	53.3	59.1	63.2	68.1
Debts:				
Real estate	16.7	18.7	20.9	23.6
Nonreal estate	12.8	14.5	17.0	20.7

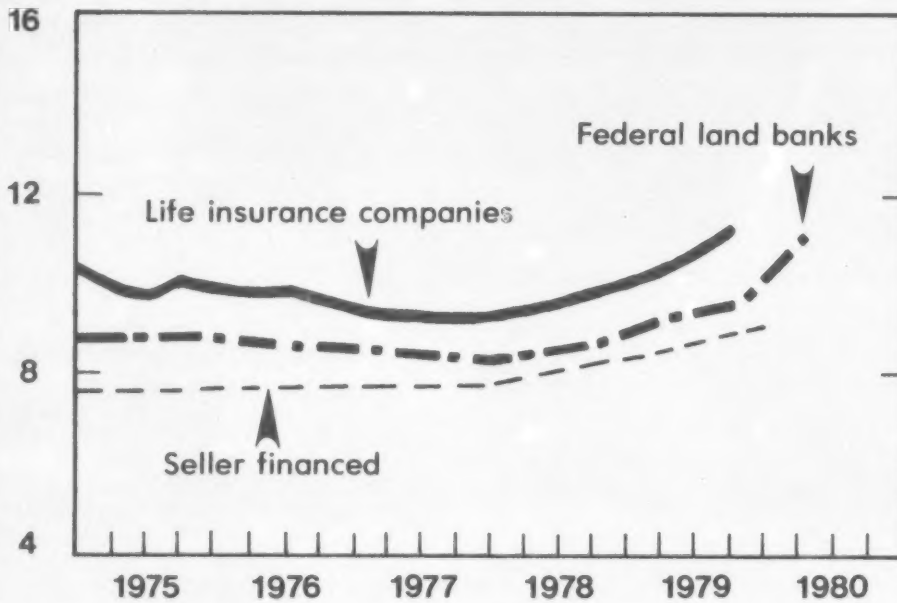
WHO HOLDS THE FARM DEBT

% OF TOTAL

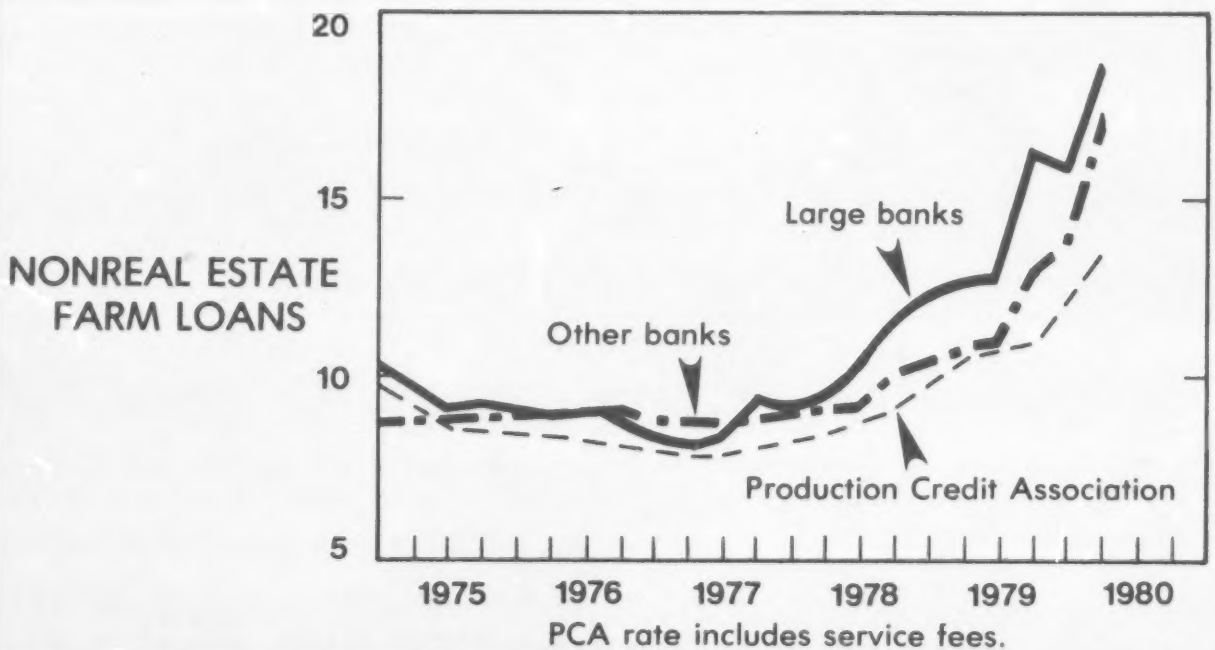


FARM INTEREST RATES

PERCENT



PERCENT



SOURCES OF AGRICULTURAL CREDIT

SOURCES	LENGTH OF LOAN	ANNUAL INTEREST RATE	PERCENT OF APPRAISAL LOAN VALUE	PURPOSE OF LOAN
COMMERCIAL BANKS & TRUST COMPANIES	6-12 MONTHS	10-13%	TO 100%	FARM PRODUCTION ITEMS MACHINERY, EQUIPMENT, AND LIVESTOCK REAL ESTATE
	2-3 YEARS	11½-12½ %	70-80%	
	10-20 YEARS	10%	60-75%	
FEDERAL LAND BANKS	20-35 YEARS	8½ % VARIABLE	UP TO 85%	REAL ESTATE
PRODUCTION CREDIT ASSOCIATION	1 YEAR	9% VARIABLE	TO 100%	PRODUCTION ITEMS MACHINERY, EQUIPMENT, AND LIVESTOCK
	3-7 YEARS	9%	VARIES	
FARMERS HOME ADMINISTRATION	40 YEARS	5%	TO 100%	REAL ESTATE MACHINERY, EQUIPMENT, AND LIVESTOCK
	7 YEARS	8¾ %	TO 100%	
INSURANCE COMPANIES	20-35 YEARS	VARIES	TO 75%	REAL ESTATE
INDIVIDUALS	15-30 YEARS	6-7%	TO 75%	REAL ESTATE MACHINERY, EQUIPMENT AND LIVESTOCK
	2-5 YEARS	6-8%	TO 80%	
EQUIPMENT MANUFACTURERS	1 MONTH-5 YEARS	17.5%	100%	MACHINERY AND EQUIPMENT

AN EXAMPLE OF THE COST OF NOT USING CASH DISCOUNTS

BUSINESS PAYMENT TERMS

3% Discount if paid in 10 days

Net price if paid after 10 days but before 30 days

EXAMPLE

20 Days financing

$\frac{20 \text{ days}}{360 \text{ days}} = 1/18$ portion of year financed

$\frac{3\%}{1/18} (.03 \times 18 = .54) = 54\%$ annual interest

NOT TAKING ADVANTAGE OF THE CASH DISCOUNT OFFERED IS THE SAME AS PAYING AN ANNUAL RATE OF 54% INTEREST.

FORMULAS FOR CALCULATING INTEREST

SIMPLE INTEREST

$$\text{Interest Rate} = \text{Principal} \times \text{Rate} \times \text{Time} \quad (I = P \times R \times T)$$

DISCOUNTED LOAN

$$\text{Interest Rate} = \frac{\text{Interest (dollar cost)}}{\text{Principal} \times \text{Time}} \quad \left(R = \frac{I}{P \times T} \right)$$

ADD-ON LOAN

$$\text{Interest Rate} = \frac{2 \times \text{No. of Payments} \times \text{Interest Charged in \$'s}}{\text{Beginning Principal} \times \text{Years} \times (\text{No. of Payments} + 1)}$$

A COMPARISON OF THE DIFFERENT METHODS OF CALCULATING INTEREST

A LOAN OF \$600.00 FOR 12 MONTHS
AT 10%. REPAYED IN 12 EQUAL PAYMENTS.

Simple Interest

$$\$600.00 \times .10 \times 1 = \$60.00 = 10\% \text{ True Interest}$$

Discounted Loan

$$\begin{array}{r} 60.00 \\ \hline 540.00 \end{array} \times 1 = .11 \text{ or } 11\% \text{ True Interest}$$

Add-On Loan (Installment Loan)

$$\begin{array}{l} \$600.00 \times .10 = \$60.00 \quad 660.00 = \text{Total Payments} \\ 2 \times 12 \times 60 = .184 \text{ or } 18.4\% \text{ True Interest} \\ \hline 600 \times 1 \times 13 \end{array}$$

AGRICULTURAL MANAGEMENT

Unit C: Agricultural Finance

Topic 3: Credit Instruments

Note: All terms underlined are included in the "Glossary of Terms."

1. Introduction to Credit Instruments

In order for a borrower and lender to be protected, there must be some kind of a legal instrument to serve as evidence that a loan has been made and to specify the repayment agreement of the loan. This evidence is usually in the form of a written agreement called a credit instrument. Several types of credit instruments are used by farmers and ranchers to conduct their businesses. Each instrument has been developed to facilitate the use of credit, increase business, increase production, and protect the borrower and lender.

Paper money, "bills," is an instrument used to transfer cash, while checks, drafts, promissory notes, warehouse receipts, bills of lading, chattel mortgages, and real property mortgages are instruments used for credit.

2. Secured and Other Credit Instruments

Credit instruments may be classified into two types, secured and unsecured. Checks, drafts, and promissory notes are unsecured, while mortgages, liens, warehouse receipts, and bills of lading are secured instruments of credit.

An explanation of unsecured credit instruments is as follows:

Checks - A check is a signed written order on a bank to pay a certain sum of money on demand to the bearer of the check or to the order of the named person on the check. There are several advantages of making payments by checks rather than using cash:

1. There is less danger of loss or theft than when carrying money or sending it through the mail;
2. The canceled check is not a receipt, but it is good evidence of payment; and
3. Record keeping is much easier if checks are used.

A draft, being very similar to a check, is charged by the bank to a third person who has previously made arrangements with the bank to accept the charges of the draft. It is not uncommon for farmers and ranchers to make an agreement with a financial institution to honor drafts drawn on the institution.

Transparency No. 1

The draft in the transparency is drawn on the Goville Production Credit Association and is signed by John Doe for the purchase of 10,000 catfish. The back side of a draft provides for endorsement and the bill of sale.

Transparency No. 2

Promissory Note - A promissory note is a signed, written promise that the debtor will pay a specified sum to a designated person or firm. It is one form of a written contract that is used as security for borrowing money, or purchasing goods or services on the credit. The promissory note is signed by one or more persons and states the interest rate, payment date(s), and the party to whom payment(s) will be made.

Texas' law permits a Confession of Judgment clause in promissory notes. This permits the creditor to take judgment without serving a process or being delayed by a trial. Should the creditor have difficulty collecting the loan, an amount is usually stipulated in the note for collection expenses and attorney fees. These additional fees usually amount to ten percent of the loan.

An explanation of secured credit instruments is as follows:

Transparency No. 3

Bill of Lading - A bill of lading is a contract or receipt signed by a common carrier (railroad or trucker) who agrees to deliver described freight to a given person at a stated place. The bill of lading serves as evidence that the carrier has received the products described. The order type and the straight type are the two types of bills of lading. While the order type may be used as security, the straight type is non-negotiable.

Bills of lading are used by farmers as collateral for credit, or they may be attached to a draft by the farmer and sent to the buyer's bank for payment. Often the seller's bank will pay the seller an amount based on a bill of lading and will send a draft and the bill of lading to the buyer's bank for payment; the buyer is notified and must honor the draft before the carrier will deliver the products. By honoring the draft, the buyer is entitled to the bill of lading, which he presents to the carrier.

Transparency No. 4

Warehouse Receipt - A warehouse receipt describes the products stored in the warehouse by a farmer and is signed by the warehouseman. This receipt, often used by farmers as collateral for loans, is an agreement between the owner and the warehouseman. The receipt usually contains the terms of the agreement, location of warehouse, date of agreement, lot number, delivery date, description of products, signature of warehouseman, and claims or liens warehouseman might have against goods.

Transparency No. 5

Chattel Mortgage - A chattel mortgage is the most common form of security used by farmers and ranchers to make short-term credit purchases. Personal property (livestock, household furnishings, and planted crops) is used as collateral for chattel mortgages. This type of mortgage allows the debtor possession and use of the mortgaged personal property; and at the same time, it gives the lender a security interest which is superior to other rights.

Lien - A lien is a claim against property for the payment of a debt. A person may secure a lien by performing certain services, defined by many states' statutes, until he has received payment for his services. If the charge goes unpaid, the person holding the lien may sell the property to secure payment of debt. A vendor's lien and a mechanic's lien are the two types of liens used most often by farmers.

Real Property Mortgage - A real property mortgage is a mortgage on immovable property such as land or other real estate. A mortgage must be in writing and must conform to state laws. A real property mortgage describes the parties entering into the agreement, the property, and the debt the mortgage secures. Some real property mortgages contain other information such as foreclosure procedures, conditions of default, payment of taxes, assignment of fee payments, assignment of loan negotiation expenses, property releases, assignment of insurance payments, and amount of insurance carried by mortgagor.

After the mortgage has been paid, the owner should secure the note marked "paid" and a "Satisfaction of Mortgage," a release from the lender stating that the mortgage has been paid in full. The owner also should have the release recorded in the county clerk's office in which the mortgage was recorded. After the release is recorded, the mortgage is canceled.

Deed of Trust - A deed of trust is an instrument conveying the title of property to a third person to hold in trust as security until the repayment of all the loan is made. A deed of trust is used when several people or firms lend money on a given piece of property. A deed of trust is similar to a real property mortgage, and the legality and foreclosure procedures are the same.

3. Usury Laws

The term usury laws has been used frequently during the period of increasing interest rates. Usury is not a new term. In Biblical times, payments for the use of money were called usury and were prohibited. In modern day terminology usury is defined as the act of lending money at a very high or unlawfully high interest rate.

Most states have usury laws which stipulate the maximum rate of interest that may be charged for certain types of loans. The Federal Land Banks, Production Credit Associations, Farmers Home Administration, and Small Business Administration are all exempt from state usury laws.

A SAMPLE DRAFT

To: **Goville Production Credit Association**
GOVILLE, TEXAS

Date January 10, 19 80

At Sight
 Pay to the order of Henry Means

\$ 1500⁰⁰/₁₀₀

Fifteen hundred and ^{NO}/₁₀₀ _____ Dollars

For items listed below, title to which is conveyed by bill of sale on reverse side hereof

Number	Breed	Kind	Age	DESCRIPTION	Weight	Price
<u>10,000</u>				<u>Channel catfish @ 15¢ each</u>		<u>\$1500.00</u>
YEAR	MAKE	DESCRIPTION			SERIAL NUMBER	PRICE

Through: **Goville National Bank**
GOVILLE, TEXAS 70-195
711

John Doe
 Buyer

A SAMPLE PROMISSORY NOTE

Goville, Texas, January 1, 19 80.

In installments as set out below after date, I, we, or either of us,
promise to pay to the order of

Goville National Bank
GOVILLE, TEXAS

One thousand fifty _____ Dollars

at the office of said bank, with interest at the rate of 10 per cent per annum from _____ until paid.

It is further agreed that any moneys or other property at any time in the possession of the Bank belonging to any of the parties liable hereon to the Bank, shall at all times at the option of the Bank, be held and treated as collateral security for the payment of this note or any other liability of the maker hereof to the Bank.

Makers, sureties and endorsers severally waive presentment for payment, notice of non-payment, protest and notice thereof, and diligence in bringing suit against any party hereto.

Due and Payable

January 1, 1981

John Doe

Betty Doe

\$ 1050.00

[illegible]

NOTICE

NO. 11565

P.O. Goville, Texas

UNIFORM STRAIGHT BILL OF LADING

GOVILLE TRUCK LINES, INC.

SHIPPER'S NO. _____

AGENT'S NO. _____

DATE _____

FROM: _____

AT _____

CONSIGNEE TO _____

DESTINATION _____

ROUTE: _____

Collect On Delivery \$ _____ and remit to: _____

No. Pkgs.	DESCRIPTION OF ARTICLES, SPECIAL MARKS AND EXCEPTIONS	*WEIGHT (Sub. to Cor.)	Class or Rate

Street _____ City _____ State _____

SUBJECT TO SECTION 7 OF CONDITIONS, IF THIS SHIPMENT IS TO BE DELIVERED TO THE CONSIGNEE WITHOUT RECOURSE ON THE CONSIGNOR. THE CONSIGNOR SHALL SIGN THE FOLLOWING STATEMENT:

THE CARRIER SHALL NOT MAKE DELIVERY OF THIS SHIPMENT WITHOUT PAYMENT OF FREIGHT AND ALL OTHER LAWFUL CHARGES.

SIGNATURE OF CONSIGNOR _____

IF CHARGES ARE TO BE PREPAID, WRITE OR STAMP HERE "TO BE PREPAID."

THE AGREED OR DECLARED VALUE OF THE PROPERTY IS HEREBY SPECIFICALLY STATED BY THE SHIPPER

SHIPPER'S SIGNATURE _____

TO BE NOT EXCEEDING _____ PER POUND PER ARTICLE.

NOTE-WHERE THE RATE IS DEPENDENT ON VALUE, SHIPPERS ARE REQUIRED TO STATE SPECIFICALLY IN WRITING THE AGREED OR DECLARED VALUE OF THE PROPERTY. THE AGREED OR DECLARED VALUE OF THE PROPERTY IS HEREBY SPECIFICALLY STATED BY THE SHIPPER TO BE NOT EXCEEDING

RECEIVED \$ _____

TO APPLY IN PREPAYMENT OF THE CHARGES ON THE PROPERTY DESCRIBED HEREON.

SHIPPER _____

CARRIER'S SIGNATURE OR STAMP _____

AGENT OR CASHIER _____

SHIPPERS ADDRESS: _____

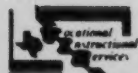
BY _____

PER
(THE SIGNATURE HERE ACKNOWLEDGES ONLY THE AMOUNT PREPAID)

"THIS SHIPMENT IS TENDERED AND RECEIVED SUBJECT TO THE TERMS AND CONDITIONS OF THE CARRIERS' BILL OF LADING AS FILED WITH THE INTERSTATE COMMERCE COMMISSION."

CHARGES ADVANCED: _____

\$ _____



WAREHOUSE RECEIPT

Goville Mohair and Wool Company

Telephone 326-7138

140 W. 23rd St.

GOVILLE, TEXAS

DATE _____ 19 ____ LOT NO. _____ GOVILLE, TEXAS
Received From _____ Freighter or Agent

Mos. Producer,

Mohair-Wool

Address, _____

[illegible]

GOVILLE MOHAIR & WOOL COMPANY

140 W. 23rd St. PHONE 326-7138

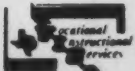
GOVILLE, TEXAS

RECAPITULATION

[illegible]

By _____ Warehouseman

Warehouseman



V.A.III

777

VI-C-3

No. 4

CHattel MORTGAGE or SECURITY AGREEMENT

A. PARTIES

Date _____

1. Debtor: _____
2. Address: _____
3. Bank: _____
4. Address: _____

B. AGREEMENT

C. OBLIGATION

1. The following is the obligation secured by this agreement:
2. List notes included in the obligation as of the date of this agreement (show date & amount):

D. COLLATERAL

1. The security interest is granted in the following collateral (describe collateral):
2. Classify goods under one or more of the following Uniform Commercial Code categories:
- | | |
|---|--|
| ☐ Consumer goods | ☐ Farm products |
| ☐ Equipment (business use) | ☐ Inventory |
| ☐ Equipment (farm use) | |

BANK, By:

Signature: _____

Typed name _____

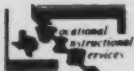
& title: _____

DEBTOR, By:

Signature: _____

Typed name _____

& title: _____



AGRICULTURAL MANAGEMENT

Unit C: Agricultural Finance

Topic 4: Principles of Borrowing

Note: All terms underlined are included in the "Glossary of Terms."

1. Obtaining Credit

Most farmers must borrow money in order to expand their farming operation and increase income. The decision to expand is not easily reached. A careful examination of alternatives available must be made, and the best one for a particular situation must be chosen.

When seeking a loan, the farm manager must be prepared to fully explain the benefits and risks to potential lenders. Many loan applications are not approved because the borrower does not present the details of the farming operation and the advantages of expanding effectively. In order to be effective, the presentation must be organized and the details of the operation should be in writing. Lenders are concerned about the benefits and risks provided by a loan, a logical presentation of facts, and the desires concerning specific agreements in the loan contract.

Information that should be included in the presentation are (1) farming plan, (2) farm records (enterprise records, expense records, net worth statement, and financial history), (3) terms of loan, and (4) method of repayment.

Several sources of credit should be investigated by the borrower before selecting a lender. The final selection should be one that best meets the needs of the borrower.

Transparency No. 1

Factors that should be considered in selecting a lender:

1. Lending institution representative's knowledge of agriculture practices and problems;
2. Lending institution representative's experience in handling agricultural credit of a similar nature;
3. Reputation of lending institution;

4. Loan policies (interest rate, repayment schedule, closing cost, penalty clause, optional prepayment clause, and policy regarding failure to meet payment because of circumstances beyond borrower's control);
5. Date loan would be advanced;
6. Possibility of increasing loan; and
7. Availability of credit for other purposes.

Since large agricultural loan applications are normally reviewed by a loan committee, it is important that the borrower have accurate and complete records of the items presented to the loan representative. However, the recommendations of the representative are usually followed. Some factors that are considered by the loan committee are listed below:

1. Will the farming enterprise provide a return sufficient to make the loan profitable?
2. Does the borrower have the capacity to repay the loan?
3. Does the borrower agree to the terms of the loan contract or mortgage?
4. Does the borrower possess the risk-bearing ability to meet loan payments and to "weather" financial uncertainties?

Answering the questions on the rating sheet below will help an agriculture manager determine if the farming operation is a good credit risk. If there are many "no" answers, the manager might find it embarrassing to answer the questions of a lender.

RATING SHEET FOR DETERMINING CREDIT RISK

Questions Regarding the Farm Family (Very Important)

	Yes	No
1. Can the manager show that with the proposed loan enough extra profit will be made to meet principal and interest payments?	_____	_____
2. Does every family member take part in making decisions and assist in farming operations according to his/her ability?	_____	_____
3. Does the manager keep well informed on new and improved farm practices that will increase farm earnings?	_____	_____

- | | Yes | No |
|---|-------|-------|
| 4. Do the family members take good care of household equipment, machinery, and livestock? | _____ | _____ |
| 5. Do family members make it a practice to pay our bills promptly? | _____ | _____ |
| 6. If family members are ever unable to pay, do they promptly explain our situation to our lender and tell him just what they can do? | _____ | _____ |
| 7. Does family try to get most of our credit from one source, so that the main line of credit for farm-production purposes is not jeopardized? | _____ | _____ |
| 8. Does family have a way to cut expenses when necessary without reducing income too seriously? | _____ | _____ |
| 9. Does family welcome suggestions from our lender about our business and financial affairs? | _____ | _____ |
| 10. Does family maintain a reserve (cash and liquid assets) large enough to meet minor emergencies, so that it won't have to ask our lender for concessions each time such an emergency arises? | _____ | _____ |

Questions Concerning Farming Program

- | | | |
|--|-------|-------|
| 1. Have we developed a long-time program for our farm, and do we develop a farm plan for each year? | _____ | _____ |
| 2. Is our farming unit (acreage and livestock program) large enough to carry a loan as well as provide income for the standard of living we want? | _____ | _____ |
| 3. Do we have the farm power, labor, machinery, tools, and equipment needed to farm for maximum profit? | _____ | _____ |
| 4. Is our farm program such that we can plan to sell our crops and livestock to the best advantage--can we, for example, sell our livestock when it is properly finished and the market offers promise of highest returns? | _____ | _____ |

- | | Yes | No |
|--|-------|-------|
| 5. Can we readily adjust our farming program to meet emergency situations and shift from operations that are losing propositions? | _____ | _____ |
| 6. If we are renting, do we have a clear understanding with our landlord on the equitable sharing of the cost of fertilizers, insecticides, and other items that will increase earnings for both owner and operator? | _____ | _____ |
| 7. Do we use a cropping system that will conserve the soil and increase earnings? | _____ | _____ |
| 8. Do we apply fertilizers and/or limestone on the basis of soil tests and yield checks? | _____ | _____ |
| 9. Will we have money left for needed farm and home improvements after meeting living expenses and loan payments? | _____ | _____ |

Questions Regarding Farm Records

- | | | |
|---|-------|-------|
| 1. Do we keep a good set of records? | _____ | _____ |
| 2. Do our records show how much money we made or lost on each separate part of our farming operations? | _____ | _____ |
| 3. Are our records in such form that we may readily show net earnings from farming operations the past several years? | _____ | _____ |
| 4. Will our records provide information needed to prepare a financial statement (assets, liabilities, and net worth)? | _____ | _____ |

Questions Regarding Loan

- | | | |
|---|-------|-------|
| 1. Will the money we propose to borrow increase our net income? | _____ | _____ |
| 2. Do we avoid borrowing on short-term notes when longer terms would be better geared to expected income? | _____ | _____ |
| 3. Do we plan for our credit needs over the entire year? | _____ | _____ |

2. Sound and Wise Use of Credit

Since there is a chance the borrower will fail to meet the financial obligations of a loan and will lose all that is owned, the borrower has much greater risk than does the lender. The borrower, however, can minimize risk by applying the following rules:

Transparency No. 2

1. Production loans should be used to increase income.

Non-productive loans reduce the amount of credit that can be secured for productive purposes.

2. Limit amount borrowed on new or unfamiliar enterprises.

Borrower should prove that he/she has management ability for an enterprise before greatly expanding the enterprise.

3. Borrower should keep debt as low as possible while still maintaining efficiency.

Loans should be used for enterprises that have the greatest profit potential and require financing for the shortest possible period of time.

4. Borrower should keep abreast of markets and trends.

Markets and trends should govern management decisions, and price projections should be based on facts. A rule of thumb that is often applicable is if prices are unusually high when a loan is secured, repayment for most of the loan will be made from lower prices.

5. The proper debt-net worth ratio should be maintained.

This is also called debt-equity ratio and is the ratio of that which is owned to that which is borrowed. Lenders prefer a ratio of 1:1 or less. A ratio of less than one indicates the owner's net worth exceeds the amount borrowed. Profitability of a business determines the risk involved. A farm showing a decline in the debt-net worth ratio has either excessive expenditures or is an inefficient operation.

6. Proper debt-income relationship should be maintained.

Estimated income should be the basis for determining the amount to borrow. The income must be greater than principal and interest payments.

7. The basis for selecting a lender should be dependability and terms of loan.

It pays to "shop" for a loan. The willingness of the lender to make adjustments during distressed times is an important consideration.

8. Borrower should have a definite repayment schedule.

Loan should be repaid from the enterprise on a definite repayment schedule.

9. Borrower should be businesslike, fair, and frank.

Loan payments should be made promptly. If conditions prevent a payment when due, borrower should discuss situation with lender in advance of due date. At the time the borrower should be able to say what can be done toward making the payment.

10. Borrower should have adequate insurance to reduce lender's risk.

Property, liability, and life insurance provide partial protection against risk. Term insurance without endowment provisions is a form of life insurance frequently used for this purpose.

3. Loan Repayment Terms

Terms of a loan (repayment plan, period of loan, and interest rate) should be adapted to the earnings or permanence of the land, buildings, and equipment. Farm buildings have a lifetime expectancy of 20 to 40 years, while farm equipment will become obsolete or wear out in five to ten years. The term of loans for these items will be different.

The term of a loan should not be for a longer period than the item's usefulness; however, the term should be long enough for normal income to be used as repayment. In determining the amount that can be paid annually on a loan, the manager should estimate operating expenses, family living expenses, and make allowances for an emergency. The amount remaining is an indication of the size of the annual payment.

Several different repayment plans are used in retiring loans. Some are lump-sum payment, amortization plan, equal payment plan, decreasing payment plan, and balloon payment plan.

When the amortization plan is used an equal amount is paid monthly for the term of the loan. The equal payment plan requires the borrower to make equal payments for the period of the loan, but the payments may be made monthly, quarterly, semi-annually, or annually.

The decreasing payment plan requires a specific payment of principal, and interest is charged on the unpaid balance. A lesser amount is paid each succeeding payment because of the reduction of interest.

If the balloon plan is used, interest payments are made at designated times; but the principal is paid in a lump sum. The principal may have a due date of one to five years.

Regardless of the repayment plan used, the borrower should select a lender whose policy will permit an optional pre-payment. This permits the borrower to pay all or any part of the loan at anytime before due date without penalty. Many lenders object to this because of the expenses incurred in making a loan, and they desire to keep their money invested long enough to return the expenses and make a profit.

FACTORS TO CONSIDER IN SELECTING A LENDER

- * Lending institution representative's knowledge of agricultural practices and problems.
- * Lending institution representative's experience in handling agricultural credit of a similar nature.
- * Reputation of lending institution.
- * Loan policies (interest rate, repayment schedule, closing cost, penalty clause, optional repayment clause, policy regarding late payments).
- * Date loan would be advanced.
- * Possibility of increasing loan.
- * Availability of credit for other purposes.

WAYS IN WHICH BORROWER CAN MINIMIZE RISK

- * Use production loans to increase income
- * Limit amount borrowed on new or unfamiliar enterprises
- * Keep debt as low as possible while still maintaining efficiency
- * Keep abreast of markets and trends
- * Maintain proper debt-net worth ratio
- * Maintain proper debt-income relationship
- * Select lender on dependability and terms
- * Have a definite repayment schedule
- * Be businesslike, fair, and frank
- * Reduce risk by carrying adequate insurance

AGRICULTURE MANAGEMENT

Unit C: Agricultural Finance

Topic 5: Banking Procedures

Note: All terms underlined are included in the Glossary of Terms.

1. Services Performed by Commercial Banks

Transparency No. 1

The principal function of commercial banks is to lend money; however, they perform many additional services. These include checking account service; savings account services; providing safe deposit boxes; managing trusts and estates; preparing cash payrolls for businesses; transferring of funds through the use of certified checks, travelers checks, and bank drafts; providing financial and investment advice; and selling and redeeming U. S. Savings Bonds.

2. Checking Account Service

Most businesses and individuals use the checking account services of commercial banks. In addition to the convenience provided by a checking account when paying bills, it also makes it easier to keep accurate records, which are essential to a business as well as to individuals.

To open a checking account, one should contact the person in charge of new accounts at the bank. The person opening the account will be provided with a signature card. The card provides space for the account name, as it will appear on the account; the signature(s) that will be used on checks; and the address, telephone number, and occupation of the person opening the account.

Transparency No. 2

The signature card may be used for an individual or a business and may be signed by one or two people. Some businesses require that a check be signed by two people, and a joint account (husband and wife or father and son) may be opened by two people. A check may be written by either against the account.

Some banks provide free individualized checks to individuals and firms maintaining large checking accounts. However, most banks provide a few personalized checks when a new account is opened; but the individual or business is charged for the printing of additional checks. Banks differ as to their policies regarding the furnishing of checks.

3. Making Deposits

A deposit slip is used for making deposits to an account. Counter deposit slips are furnished by the bank. This type of deposit slip is filled out in duplicate. The bank retains one copy; and the person making the deposit gets the second copy, which serves as a record of the deposit. Also, deposit slips are provided in the back of a personalized checkbook. Single or duplicate copies are made when using these deposit slips. This type of deposit slip is often used when placing a deposit in a night depository.

Transparency No. 3

The procedure for filling out a deposit slip and the type of deposit slip used varies with each bank. Usually, silver and currency are listed first; and checks drawn on the bank in which the deposit will be made should usually be listed next, followed by the other community banks, and finally, banks in other cities. Cash deposits made by mail should be sent by registered mail.

4. Endorsing Checks

Checks should be endorsed across the left end of the back of the check before being deposited or transferred to another person. If a check is being deposited and the name on the face of the check is different from the name on the signature card or account name, the first endorsement should be as it is written on the check; and the second endorsement should be the same as the account name on the signature card.

Transparency No. 4

There are three different kinds of check endorsements: restrictive, blanket endorsement, and full endorsement; each is used differently.

The restrictive endorsement is used to protect the bearer from loss in the event an unauthorized person gets possession of the check. This type of endorsement should be used if a check is being deposited by mail.

The blanket endorsement is used when the payee cashes a check and receives the cash. A check may be cashed by the person who has possession when a blanket endorsement is used.

A full endorsement protects the holder from loss or theft, and the check can be transferred only after the holder endorses it.

5. Writing a Check

A check is an order to a bank to pay the person named, bearer, a specific sum of

money. A person may be asked to make payment by a certified check, a check stamped with the word "certified" and signed by the bank cashier. The amount of the certified check is taken from the depositor's account when the check is certified so that funds are available for payment when the check is presented to the bank. The bank assumes the responsibility for the payment of certified checks.

When writing a check, the following factors should be kept in mind:

1. All checks should be written in ink, as they are much more difficult to change;
2. The writing should be legible, and neither the holder nor the bank should have difficulty reading it;
3. Never sign a blank check. This places your bank account in the hands of the holder of the signed blank check. If a mistake is made in writing a check, it should be destroyed and another check written; and
4. In the area provided on the check and usually at the bottom left (For _____), one should designate the item for which the check was written. This will help complete the record of payment, and many businessmen will accept this as a receipt.

Transparency No. 5

The following numbers, one through six, give an explanation of the different areas to be filled in when writing a check and correspond to the numbers in Transparency No. 5.

1. Checks are numbered consecutively. This helps the depositor identify his account balance with the balance shown on the bank statement. This also will help in identifying lost or misplaced checks.
2. This is the date the check is written. Checks may be dated on any day, including Saturday and Sunday; however, checks should not be postdated, dated ahead.
3. The payee, the name of the person or firm to whom the check is written, goes on this line. Checks made payable to "cash" can be cashed by anyone. When withdrawing money from one's account the check should be made payable to "bearer."
4. There should be very little, if any, space left between the amount of the check and the dollar sign, which is located to the right of the bearer's name on the check.
5. The written line which gives the amount of the check should be completely filled.
6. Line six on the check is for the maker or drawer. His signature should appear as it is on the signature card.

The maker of a check may stop payment on the check anytime before it has been presented to the bank for payment. The procedure for stopping payment varies with different banks. Most banks require the maker of the check to sign a written order

for the bank to refuse payment, and most banks charge a fee for stopping payment on a check. Probably the most common reason for stopping payment is because the check has been misplaced or lost.

6. Check Stub, Service Charges, and Balancing (reconciling) Checking Account

To avoid the writing of a bad check, often called a "hot check", because of insufficient funds, the depositor should keep an accurate record of deposits and withdrawals. Completing the check stub before writing each check and entering deposits on the check stubs should prevent the writing of a bad check. This keeps the depositor aware of the bank balance at all times.

Transparency No. 6

One type of check stub is shown in the above transparency. Several different types are in use, but the principle for using them and keeping an accurate record of the bank balance is the same.

Most banks have a service charge for checking accounts. The type of charges and the basis used to determine charges vary among banks. Usually the service charge is based on the number of checks written during the month and the average monthly balance of the account. Accounts with a large monthly balance usually are not charged a monthly service charge. The service charges of one bank are as follows: insufficient funds or overdraft - \$7.50; overdraft paid - \$7.50; stop payment - \$5.00; personal checking account service charge - balance of 0 to \$99, \$4.00; bal. \$100 - \$199, \$3.00; bal. \$200 - \$299, \$2.00; bal. \$300 - \$399, \$1.00. If the monthly average balance remained \$400 or more, this bank does not charge a service charge for maintaining the checking account. Students and nonprofit organizations are exempted from paying a service charge by many banks.

The holder of an active checking account is sent a monthly statement from the bank which lists checks written, deposits, service charges, average monthly balance, and account balance. Cancelled checks also are enclosed with the monthly statement.

Transparency Nos. 7 and 8

It is assumed in transparency Nos. 7 and 8 that this is the monthly bank statement for Jack Jones, a fictitious person. The statement is for the month of July. According to the statement Jack has written seven checks and made three deposits. However, he has written two checks, one for \$38.07 and another for \$60.00, which have not been presented to the bank for payment. Also, one deposit for \$135.00 was made after the statement was prepared by the bank. The above information is used to reconcile the statement with the checkbook.

SOME SERVICES PERFORMED BY BANKS

- ◆ Checking Account Service
- ◆ Saving Account Service
- ◆ Safe Deposit Boxes
- ◆ Managing Trusts and Estates
- ◆ Preparing Cash Payrolls for Businesses
- ◆ Transferring Funds By Certified Checks
- ◆ Issuing Travelers Checks
- ◆ Providing Bank Drafts
- ◆ Providing Financial and Investment Advice
- ◆ Selling and Redeeming U.S. Savings Bonds

SIGNATURE CARD FOR A FIRM OR INDIVIDUAL

ANYWHERE NATIONAL BANK, ANYWHERE, TEXAS

is hereby authorized to recognize the signature below
in the payment of funds or the transaction of any other
business for my account.

Signature _____

Home address _____

Business address _____

Occupation or business _____

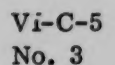
Signature _____

Signature _____

Date _____

Front

CURRENCY		
CHECKS		
TOTAL		

[illegible]

CHECK ENDORSEMENTS

Restrictive Endorsement

For Deposit in
Groville National Bank
To Credit of
Henry Means
OR
For Deposit Only
Henry Means

Full Endorsement

Henry Means

Blanket Endorsement

Pay to the order of
Jane Means
Henry Means

A PROPERLY WRITTEN CHECK

2
1
4

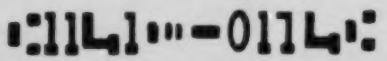
Anywhere, Texas Jan. 1 19 82 No. 84

Anywhere National Bank

pay to
the order of Henry Means \$ 150 ²⁵/₁₀₀

One hundred fifty and ²⁵/₁₀₀ Dollars

For 8 feeder pigs

 John Doe

3 5 6

A COMPLETED CHECK STUB

NO. 84 \$ 150 ²⁵~~xx~~

DATE Jan. 1 19 82

TO Hensley Means

FOR 8 feeder pigs

	DOLLARS	CENTS
BALANCE BRO'T FOR'D	845	00
AMOUNT DEPOSITED	75	00
" "		
TOTAL	920	00
AMOUNT THIS CHECK	150	25
BALANCE CAR'D FOR'D	769	75

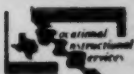
BANK STATEMENT

Goville National Bank
Goville, Texas 77777

Mr. Jack Jones
 Goville, Tx 77777

ACCOUNT NUMBER	PAGE NUMBER
106786	1
7-1-80	7-31-80
FROM	TO
STATEMENT PERIOD	

ACCOUNT NUMBER	BEGINNING BALANCE	NO OF CREDITS	TOTAL CREDITS	NO OF DEBITS	TOTAL DEBITS	FEE	ENDING BALANCE
106786	400' 00	3	700' 00	7	476' 50	' 00	623' 50
ACCOUNT NUMBER	CHECKS	CHECKS		DEPOSITS	DATE	BALANCE	
				400' 00	1-80	800' 00	
	12' 00				2-80	788' 00	
	8' 50				3-80	779' 50	
	6' 00				4-80	773' 50	
	150' 00				9-80	623' 50	
	250' 00			100' 00	10-80	723' 50	
	25' 00				12-80	473' 50	
					14-80	448' 50	
	25' 00			200' 00	16-80	648' 50	
					18-80	623' 50	
						623' 50	
NUMBER OF ENCLOSURES		CODE EXPLANATION - SEE OTHER SIDE					



V.A. III

801

VI-C-5
 No. 7

CHECKBOOK RECONCILIATION

NO.	\$	
50	38	07
51	60	00
TOTAL	\$	98 07

BALANCE 660.43

PLEASE REPORT ANY DISCREPANCIES WITHIN 14 DAYS

EXPLANATION OF CODE

PU	PAID OUT
PR	PRINCIPAL
RA	REVERSED AMOUNT
RC	DEPOSIT CHECK RETURNED
RI	RETURNED ITEMS
RP	REVERSED PRINCIPAL
RT	RETURNED ITEM
SC	SERVICE CHARGE
TR	TRANSFER DEBIT
TX	TAX DISBURSEMENT
WD	WITHDRAWAL

AGRICULTURAL MANAGEMENT

Unit D: Agricultural Planning

Topic 1: General Rules of Planning a Farm Business

Note: All terms underlined are included in the "Glossary of Terms."

1. Farm Planning

The importance of planning cannot be over emphasized. It is doubtful if any business, regardless of its size, will grow and prosper as it should without detailed planning. Many large businesses maintain full-time staffs which spend their time planning, analyzing, and summarizing their businesses. The business aspects of farming are similar to other businesses, and the farm owner, operator, or manager should devote a great deal of time to planning.

To be useful, farm plans must be easily followed and should cover all phases of the farming operation. Generally, farm plans are formulated to acquire the greatest net profits from the farming operation rather than maximum production; however, profits and production are closely related.

Even though the planning of two farms will be different, there are some general rules in planning that should be helpful if followed. These are listed in the following transparency.

Transparency No. 1

After a farmer has become acquainted with the general rules for planning, there are logical steps which should be followed in making plans.

Transparency No. 2

Step No. 1 - Before planning the business, the farmer must have a knowledge of the available resources: land, capital, labor, and management. Land resources are the land owned, land rented, the natural resources (light, air, rainfall, and forest) and mineral resources (oil).

Capital resources are farm improvements and include equipment, machinery, livestock, and supplies.

The inventory should also list the amount of capital available, both cash and credit.

Family labor, hired labor, and the manager's labor are the three kinds of labor to be considered and this refers to mental as well as physical labor.

Management is a resource often overlooked when making the resource inventory. Most farms, particularly the family farm, cannot justify the expense of hiring full-time managers, but there are some management services available to the owner-manager that should be included in the inventory. The market analysis service, provided for a nominal fee by several commercial firms, is one example of a management service available to farmers.

Step No. 2 - The land-use program will be a major factor in determining the type of farming program. The services of several governmental agencies (S.C.S. and A.S.C.S.) should be solicited in determining the land-use program.

A farm having a S.C.S. conservation plan will have a partially planned land-use program, as this is included in the S.C.S. plan.

Step No. 3 - To estimate the value of crop production, the farm can use the average yields over a period of years from several farms in the area. If this information is not available, county yields on most crops are available from the State Department of Agriculture or the U.S. Census of Agriculture. The county yields include the yields from all farms in the county; therefore, a good manager should be able to obtain about twenty percent more yields than the county average without much difficulty.

Step No. 4 - The inclusion of livestock into the farming program will usually increase the net income and give a more even distribution of labor. On most farms in Texas there are already some livestock facilities which may be another advantage of fitting livestock into the farming plan.

Step No. 5 - If livestock can be added to the farming program plans, an estimate of the increase in income should be made. Kinds and amounts of labor, capital requirements, and facilities needed should be listed.

Step No. 6 - In addition to the information contained in the plan after completing Steps 3-6, the following charts should be helpful in determining the labor, power, and machinery requirements.

Annual Labor Requirements for
Dairy Cows, Beef Cows, Hogs, and Poultry

Animal	Hours of Labor Required
Breeding beef cow, including calf	18
Fattening beef animal on full feed	2.0
Laying hens, 100 hd.	200
Brood sow, hours per litter	20
Fattening hog	2
Milking dairy cow	76
Breeding ewe, including lamb	10
Fattening lamb	2

The above are average labor requirements for an economical unit, and they may be reduced or increased on some farms.

Labor Requirements Per Acre for
Different Crops

Crop	Hours of Labor Required per Acre
Corn	3
Small grains	1
Hay, per cutting	.7
Vegetable crops (average)	17
Fruit trees	12

Farm Machinery Repair Costs

Machine	Annual Repair cost in percent of original cost	Total Repair Cost over life of machine in % of new cost
Tractor	3.5	35
Plow, one-way	5.0	80
two-way	7.0	--
Harrow, disk	3.0	30
Drill, grain	1.5	25
Planter, corn	2.0	30
Cultivator	3.5	40
Combine	3.0	40
Baler, hay	3.0	40

Average Fuel Consumption

		Fuel per Hour					
		<u>Gasoline</u>		<u>Diesel</u>		<u>LP Gas</u>	
		75%	50%	75%	50%	75%	50%
Plow	Hp	Load, gal.	Load, gal.	Load, gal.	Load, gal.	Load, gal.	Load, gal.
3-4	35-49	3.4	2.8	2.6	2.1	4.2	3.4
4-5	50-69	5.0	4.0	3.9	3.1	6.0	4.9
5-6	70-89	6.8	5.5	5.0	3.9	7.9	6.4
6-7	90+	---	---	6.2	4.9	9.4	7.5

Lubrication Cost For Farm Machinery

1. Gasoline wheel tractor - 1.6% of original investment or .08 to .10 per hr.
2. Field machines - .04% of original cost
3. Combine - 1% of original cost, excluding crankcase oil

The power and machinery costs may be determined by figuring the cost of the machinery, machinery depreciation, operation cost (fuel, repairs, and labor), and the number of years the particular machine will last under normal conditions. It may pay some farmers to hire a crop custom harvested rather than buy a piece of machinery and harvest the crop themselves. The farmer may wish to determine the machinery cost per acre (divide the number of acres on which the machine is used into the machine's annual cost) in deciding whether to purchase or hire a crop harvested.

Step No. 7 - In this step, the responsibilities of each of the family members are planned and recorded. Also, the use of family and hired labor will be planned.

Step No. 8 - A reasonably accurate estimate of net earnings should be determined, and alternate plans should be considered. If the estimated net earnings, the amount left after subtracting expenses, are not sufficient to support the standard of living desired by the family, other plans should be made.

Step No. 9 - In this step an outline of the procedure and sequence that will be followed in the transition from the old to the new plan should be developed.

3. Testing the Plan

Testing of the plan should begin as soon as each phase of the plan is executed. Revisions and improvements are essential and should be made as the plan is being followed. Analysis of accurate records is one of the best methods of determining necessary revisions and improvements.

GENERAL RULES FOR PLANNING

1. Farming program should fit the knowledge, interest, and capabilities of the farm manager.
2. Farming program should be large enough to support the farm family.
3. The plan should be for a long-term.
4. The plan should be based on maximum income.
5. The plan should be based on available markets and the productivity of the land.
6. In plans that include crops, the crops selected should be based on soil type and fertility.
7. In plans that include livestock, the enterprise should be large enough to consume farm-raised feed.

STEPS IN FARM PLANNING

1. Inventory of farm resources

Land { Owned
Rented

Labor { Family
Hired

Managements { Market analysis
Bookkeeping

Capital { Cash
Credit
Improvements
Supplies
Etc.

2. The land-use program

3. Estimate the value of crop production

4. Livestock plan

5. Estimate the value added by livestock

6. Plan the labor, power, and machinery needs for the farm

7. Plan the farmstead organization

8. Estimate net earnings and consider alternative plans

9. Plan the physical and financial transitions from the old to the new plan

AGRICULTURAL MANAGEMENT

Unit D: Agricultural Planning

Topic 2: Determining the Enterprise and Farm Costs

Note: All terms underlined are included in the "Glossary of Terms."

1. Limited Capital and Opportunity Costs

Since capital is usually a limiting factor in agricultural production, farmers must divide or allocate their funds among the different enterprises on the farm. If a farmer has unlimited funds, other resources such as land and labor are usually limited; therefore, most farmers must decide the best combination of livestock and crops for their particular farm based on the resources available.

To determine the enterprises that will give the greatest returns, a farmer must consider the enterprise combinations. An expansion of one enterprise usually limits another enterprise. The farmer must decide the amount of capital, labor, and acreage to devote to each enterprise in the combination to receive the greatest returns. The principle of opportunity costs can be helpful in making these decisions.

When properly applied, the principle of opportunity costs, also known as the equal added return principle, will give the greatest returns when each unit of capital, labor, and land is used to add the most returns to a farm enterprise; this does not mean the greatest average returns but the greatest added returns. The principle is illustrated in the Transparency No. 1, and an explanation follows.

Transparency No. 1

The figures given in the transparency are based on a 120 acre Midwest general purpose farm. Differences in the figures are due to the fact that a greater investment usually requires hired labor or the purchase of additional feed.

After reviewing the transparency, one should determine that the swine enterprise is the most profitable if average returns were used. This enterprise produced an income of \$1.25 for each dollar invested. However, after applying the principle of opportunity costs to determine the greatest overall returns and

the combination of enterprises, the first \$1,000 should be invested in the chicken enterprise because it has a gross return of \$1,500. The next \$1,000 should be invested in dairy cows, for they produce the second greatest returns, or \$1,400. The third and fourth \$1,000 should be invested in hogs, since they will return \$1,300 for each \$1,000 invested. Investing the \$4,000 as suggested would produce a gross income of \$5,500. This is a profit of \$1,500 compared to a \$1,000 profit using the average return method.

To use the principle of opportunity costs, a budget must be prepared for each enterprise. The planner also would need to prepare an enterprise budget varying the scope of the enterprise.

2. Combining and Replacing Enterprises

One of the greatest problems that a farmer has is in deciding which combination of enterprises will give the largest net profit. Decisions relative to the combining of enterprises or of replacing one enterprise with another are determined by the relationship among enterprises. These relationships may be classified as independent, competitive, supplementary, or complementary.

Independent enterprises are enterprises which do not have any relationship with other enterprises. An increase in a resource in an independent enterprise would not increase or hinder another enterprise. This type of relationship is usually confined to the farmer with unlimited capital resources.

Competitive enterprises compete for a farmer's resources. When two enterprises are competitive, the production of one enterprise is reduced while the other is increased. Dairying and beef cattle are examples of competitive enterprises.

There are three factors that determine the most profitable combination of competitive enterprises:

1. The rate at which one enterprise substitutes for another;
2. The price of the products; and
3. The cost of producing the product

If two crops have the same production costs, the substitution rates and the prices of the products determine the best combination.

Supplementary enterprises may neither add nor compete with each other. An example of a supplementary enterprise might be a small poultry operation,

which would use family labor, existing buildings, and possibly some feed that would otherwise go to waste. An expansion or decrease in the enterprise would not change other enterprises. Price does not have a bearing on supplementary enterprises as long as the returns are greater than the cost, and it is not profitable to shift from one enterprise to another as long as the two enterprises supplement each other.

Complementary enterprises complement each other, and they do not compete with or serve independently of each other. Often an increase in production of one enterprise will cause an increase in the production of the other. A forage crop might be a complementary enterprise to a grain crop by adding organic matter and nitrogen to the soil, which in turn will increase the production of the grain that follows. The enterprises must be in the right combination or proportion to be complementary, and all enterprises at some point will be competitive. As soon as they become competitive, prices and returns become important.

3. Importance of Farm Budgeting

As has been stated previously, the most successful farmers generally are those who make detailed plans. Budgeting, a detailed estimate of income and expenses, is one form of planning.

Since farming technology, competition, and government programs are constantly changing, farmers have to change and adjust their operations. Sometimes it becomes necessary for a farmer to change a part or all of his farming operation. If so, a well-planned farm budget, with the objective being to compare alternate plans for prospective profits, can be useful in helping the farmer select the best choice of enterprises with the available resources. The budget should help the farmer decide the best production methods, the size of machinery to use, whether to use hand labor or machines, and whether to own or rent equipment. There are seven basic factors which are usually considered when the farmer makes changes in his farming program.

Transparency No. 2

Among the factors to be considered in adjusting the farm program are the changes which affect the yield and rate of production. Changes may be indicated in the amount of seed to plant per acre, insecticide to use, amount and kind of fertilizer to use, amount and kinds of feed, and whether to irrigate or not.

Examples of changes that may be made in production methods are the substitution of equipment for labor, owning equipment rather than hiring a custom operation, raising replacement livestock rather than buying them, and changing the feeding system.

When considering the possible uses of capital, the deciding factor in determining the adjustment to be made would be the one that gives the best returns.

The size of the farming program has a very close relationship with each of the factors to be considered in adjusting the farming program. For example, it will affect the amount of capital required and the selection of enterprises.

The enterprise adjustments are determined by the owner's or manager's skill and "know-how" and the expected profits from the change.

The problem of expansion is a factor in all farming programs. The basic decision to consider before expanding is whether to buy or lease land.

The possibility of vertical or horizontal integration, contracts, leasing arrangements, partnership agreements, and incorporating are considered in the business operation.

4. The Kinds and Uses of Different Budgets

There are three kinds of budgets used by farmers. They are the partial budget, enterprise budget, and complete budget. The partial budget, used as a decision making technique by farmers, involves only a part of the total farming program and does not change the complete budget. It is used to estimate the changes in costs and/or income if production changes are contemplated. Changes in production such as increasing and decreasing fertilizer consumption, increasing or reducing an enterprise, and substituting capital for labor would necessitate the making of a partial budget.

There are two kinds of production costs, fixed and operational, that are used in making farm budgets. Fixed costs are those items of expense, such as taxes and depreciation, which do not change. Operational costs are expenses which are affected by a change in the level and scale of production.

The following example illustrates how a partial budget may be used by a farmer in making a decision as to whether to buy a combine or hire a custom operator to combine a grain crop.

The farmer has 400 acres of milo to combine. A new combine, with a useful life of 10 years, can be purchased for \$40,000. The cost of hiring the milo custom combined is \$12.00 per acre. Based on the purchase price of the combine, the expenses shown in the transparency below could be expected.

Transparency No. 3

The enterprise budget is used to estimate the returns from an enterprise

such as cotton, corn, beef cattle, and forage crops. The income and expense estimates for an enterprise can be obtained from the farmer's previous records of an enterprise or by making a comparison of results obtained in the county or area.

Transparency No. 4

The complete budget, being especially valuable to the beginning farmer, tenant farmer, and a farmer farming a farm for the first time, is an estimate of the total cost and returns for an entire farming operation and is compiled from all of the enterprise budgets. A budget cannot always be followed as planned, and it must usually be amended.

Transparency No. 5

ADDED RETURNS FROM USING THREE LIVESTOCK ENTERPRISES

AMOUNT OF CAPITAL USED	HOGS	CHICKENS	MILK COWS
\$1,000 _ _ _ _	1,300	1,500	1,400
2,000 _ _ _ _	1,300	1,250	1,100
3,000 _ _ _ _	1,200	1,090	1,050
4,000 _ _ _ _	1,200	1,090	1,050

RETURNS FROM \$4,000 CAPITAL

5,000	4,930	4,600
-------	-------	-------

AVERAGE PER DOLLAR INVESTED AT \$4,000

\$1.25	\$1.23	\$1.15
--------	--------	--------

FACTORS CONSIDERED IN ADJUSTING THE FARM PROGRAM

1. Changes that affect yield and rate of production
2. Changes in methods of production
3. Use of capital
4. Size of operation
5. Enterprise
6. Is the operation suitable for expansion
7. Business operation

OWNERSHIP EXPENSES

FIXED COSTS

\$40,000 - Cost of combine

500 - Salvage value of combine

\$39,500

Depreciation — \$39,500 — 10 yrs. — \$3,950.00

Interest — 11.5% — $\frac{1}{2}$ of new cost — 2,271.25

(Average Investment -

\$19,750 X 11.5 = \$2,271.25)

Insurance — 2% of new cost — 790.00

Housing — .007% of new cost — 276.50

Total Fixed Cost - \$7,287.75

OPERATIONAL COSTS

Repairs — 3% of new cost — \$1,185.00

Fuel — 144 hrs. @ \$1.50 per hour — 216.00

Labor — 144 hrs. @ \$4.00 per hour — 576.00

Total Operational Cost - \$1,977.00

$\$7,287.75 + 1,977.00 = \$9,264.75 - 4,800.00 = \$4,464.75$

The loss from purchasing a combine would be \$4,464.75.

COTTON ENTERPRISE BUDGET

PRODUCTION EXPENSES

Cost per Acre

Tractor and equipment _ _ _ _ _	\$15.00
Labor _ _ _ _ _	42.00
Seed, fertilizer, and insecticides _ _ _	70.00
Total	\$127.00

HARVESTING EXPENSES

Desiccation _ _ _ _ _	\$3.50
Harvesting, machine _ _ _ _ _	60.00
Ginning _ _ _ _ _	25.00
Total	\$88.50

Total production
and harvesting expenses \$215.50

INCOME

Lint @ .58 per pound (500 lbs.) _ _ _	\$290.00
Seed @ \$4.00 per cwt. (1000 lbs.) _ _ _	40.00
Total Income	\$330.00

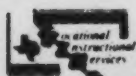
$\$330.00 - 215.50 = \$114.50$ returns to
Land, Capital, and Management

A SAMPLE COMPLETE BUDGET

<u>ITEM</u>	<u>RECEIPTS</u>	<u>ITEM</u>	<u>EXPENSES</u>
<u>Livestock</u>		<u>Operational Costs</u>	
Cattle	\$9,900	Livestock	\$8,500
Hogs	4,829	Crops	10,000
Poultry	413	Tractor, other	400
Total	\$15,142	Equipment, other	300
<u>Crops</u>		Hired Labor, other	1,000
Cotton	\$10,500	Misc.	500
Corn	3,800	Total	\$20,700
Total	= \$14,300	<u>Fixed Costs</u>	
Total Gross Income	= \$29,442	Taxes	\$450
		Interest	400
		Insurance	300
		Improvements	500
		Total	\$1,650
		Total Expenses	\$22,350

(\$15,142 + \$14,300 = \$29,442)

Net Farm Income \$29,442 - 22,350 = \$7,092



AGRICULTURAL MANAGEMENT

Unit D: Agricultural Planning

Topic 3: Planning Equipment Purchases

Note: All terms underlined are included in the "Glossary of Terms."

1. Importance of Planning Machinery and Equipment Purchases

According to the U. S. Department of Agriculture, equipment purchases represent from 20 to 60% of the expenditures on southern farms. Larger farms, rising prices, efforts to increase production and efficiency, and a decrease in the available labor supply, which has been continuous during the post W. W. II years, have contributed to the increase in the use and expenditures of farm machinery and equipment.

Farmers purchase machinery and equipment to increase their net profits; but in order to increase profits rather than decrease them, time must be spent planning machinery and equipment purchases. There are several factors that the farmer should consider in planning these purchases.

Transparency No. 1

2. Determining the Capacity of Equipment Needed and Selecting Equipment

After selecting the type of machinery for the job, the farmer must determine the size of machine that is needed. To determine the proper size of machinery, the farmer should consider the number of acres to be worked, width of the machine, speed the machine will travel, and the maintenance and service time. A formula can be used to determine the number of acres that a machine can cover in an hour.

Transparency No. 2

The formula uses the working width of a machine, speed of travel, efficiency of the machine, feet per mile, and the square feet per acre to determine the number of acres that may be worked in an hour. All of the factors are self-explanatory, with the exception of the efficiency factor. The efficiency factor is an indication of how much time is lost due to servicing the machine, turning, loading, unloading, etc.

As a rule-of-thumb, machinery generally is considered to have an efficiency factor of .825; but this factor needs to be adjusted for different farm situations. The formula used above includes the efficiency factor. After the farmer has calculated the number of acres worked per hour, the number of hours required to complete a job can be determined.

Another factor that should be considered by the farmer in determining the size of equipment needed is the number of working days in a season in which a particular job may be performed. After this is determined, the farmer usually assumes that he will have about one-half of the working days to perform the job. Weather and other factors usually prevent having more time.

The type and condition of the soil, other factors to be considered in determining the size of equipment, will affect the amount of time a machine requires to perform a particular job. There is a considerable variation, caused by differing soil conditions, in the implement draft of field machines.

3. Determining Costs of Owning Farm Machinery and Equipment

The cost of owning farm machinery and equipment can be divided into fixed cost and operating costs. Fixed costs are costs that continue regardless of whether the equipment is used or not and include the original cost (initial investment), service life (depreciation), interest on investment, and miscellaneous costs such as taxes, insurance, and housing. Operating costs will vary depending upon the use and conditions under which the machinery is used and include fuel costs, repair and maintenance costs, and labor costs.

FIXED COSTS

Original Cost - The original cost is the amount of money that the farmer invested in the equipment when it was purchased. About the only way that a farmer can influence the original cost of a piece of equipment is by being a good shopper (check the prices of several dealers).

Depreciation - Depreciation is an unavoidable loss and is the cost resulting from wear and obsolescence of farm machinery. It is necessary that the farmer be familiar with the depreciation cost, for he must make budgets and cost predictions. There are two kinds of depreciation: time depreciation and wear depreciation. Time depreciation is the charge for a machine used very little, while wear depreciation is based on the use of the machine. The ideal situation is when a machine is used enough that the wear depreciation and time depreciation are equal. If a piece of farm equipment is used to the extent that the wear depreciation is faster than the time depreciation, due to obsolescence, the depreciation cost will increase proportionally to use. However,

other fixed costs will be reduced if a machine is used in excess of the amount necessary to reduce the time depreciation. A more detailed explanation of depreciation is given in the topic "Depreciation."

Interest on Investment - Since the money used to purchase a machine cannot be used for other purposes, the farmer must consider the interest on his investment in the machine as a cost of owning the machine. It is usually easier and more convenient for the farmer to charge the same interest each year of the machine's life; therefore, the interest charges are usually based on the average investment for the life of the machine.

The average investment is calculated by taking one-half of the initial investment plus the trade-in value of the machine and divide by two. For example, a \$2,000 piece of equipment with a trade-in value of ten percent of its initial cost (\$200) would have an average investment of \$1,000 ($\frac{2,000 + 200}{2} = \$1,100$.)

The annual interest figured at 10% on the investment would be $\$1,100 \times 10 = \$110.00$. The average value of the machine can be determined for the machine any year, and the interest figured on this value.

Taxes - The tax rate on farm machinery and equipment is the same as it is on farm real estate. Generally, the taxes for the life of a machine equal about one percent of the purchase price.

Insurance - Insurance rates vary, and the farmer either insures his equipment or carries the risk himself. Insurance cost approximately 2% of the initial cost of the equipment annually.

Shelter - Many farmers do not provide shelter for their machines; however, research has proven that equipment lasts much longer when it is sheltered during the off-season. Shelter cost will vary, but some farmers estimate this cost to be .007% of the initial cost.

Transparency No. 3

The total fixed costs of owning machinery and equipment may be expressed as a percentage of the original cost. In the above transparency, the ownership costs are shown as a percentage for new and used livestock and field equipment. Depreciation calculations are based on 10 years of useful life for new equipment and five years for used. Repairs are greater for the used equipment because it is partially worn.

OPERATING COSTS

Operating costs include fuel, oil, lubricants, repairs and maintenance, and operator's labor.

Fuel, Oil, and Lubricant Costs - Fuel, oil, and lubricants represent a large portion of the operating costs and are more than the initial cost of a machine, if these costs are figured for the life of the machine. In order to make accurate cost estimates, a farmer must be able to determine the fuel consumption of machines. These estimates generally are made in two ways: charts have been developed which will give the fuel consumption of different sizes of tractors, or a formula may be used. The following formula may be used for figuring fuel consumption:

$$\text{Daily Fuel and Oil Costs} = \text{Belt Hp.} \times .8 \text{ fuel price per gallon}$$

This formula also includes an allowance for grease.

The labor used to lubricate a machine usually costs more than the lubricant. It is difficult to estimate the cost of lubricating machines because of the many kinds and types; however, the lubricating cost will usually vary between .4 and .01% of the initial cost of the machine.

Repair Costs - The amount of use, nature of use, and care and maintenance will influence the cost of repairs. It is estimated that repairs during the life-time of the machine will usually cost about thirty-five percent of the initial cost of the machine. For example, a new field machine with an expected life of ten years could be expected to cost 4.5% of the initial cost annually.

Labor Cost - The labor cost must be included in the operating cost of a machine. The type of machine will influence the amount of labor required. Usually, labor cost represents approximately 47% of a machine's operating cost.

A number of factors in addition to the amount of labor saved should be considered when purchasing machinery and equipment. Increase in farm profits, profitability of using labor elsewhere, increase in leisure time, and family obligations are some of the considerations.

Using the formula in the following transparency will assist in determining the profitability of a proposed purchase.

Transparency No. 4

In the above example, a farmer is considering the purchase of a new, larger field machine that will save 420 hours of labor annually. Labor is calculated

at \$4.00 per hour.

The appropriate annual cost of ownership is located in transparency No. 3, and this is divided into the amount of labor saved. The resulting figure is the amount that can be spent for the new field machinery without affecting profits. In the example, the farmer could spend \$7,636.36 to replace labor with a capital item. Should the farmer have to pay \$8,500.00 for the machinery, it would not be profitable. However, if the machinery cost \$5,500, it would be extremely profitable.

4. Ways of Cutting Machinery and Equipment Costs

Based on acreage and capital requirements, many farmers cannot justify the expense of owning certain items of farm equipment. Some farmers could reduce much of their overhead if they secured the use of equipment by some means other than by purchasing it.

There are several alternatives which should be considered when trying to reduce equipment costs. Some of these are joint ownership of equipment, exchange of work with other farmers, leasing equipment, hiring a custom operator, and individual ownership. With the exception of leasing equipment, the farmer should be able to determine the costs of the alternatives listed above. The leasing period will affect the rate charges. The following transparency provides some leasing periods, possible rates, and a formula for evaluating a lease.

Transparency No. 5

The example given under the formula uses the following:

Machine retail value of \$10,000	
Length of lease	5 years
Annual lease rate	24% of lease price
Each annual payment is	\$2400 (10,000 x .24)
Total of 5 payments $2400 \times 5 =$	\$12,000 cost of using machine
\$12,000 - \$10,000 (retail value of machine)=	\$2,000 (total additional cost of lease or finance charge)

Since payments are prepaid, the original unpaid balance is reduced to \$7,600 (\$10,000 - \$2,400 down payment), which becomes in effect the lease face value. Therefore, only four installments remain.

If an operator could obtain a simple interest bank loan to purchase equipment less than 10.9%, it would be more profitable to purchase equipment.

References:

1. "What It Costs To Use Farm Machinery", Agricultural Experiment Station, Kansas State University, B-417.
2. Bishop, Frank E. and William J. Promersberger, Modern Farm Power, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1962.
3. "Estimating Farm Machinery Costs", Virginia Agricultural Extension Bulletin, B-290.

FACTORS TO CONSIDER IN PLANNING MACHINERY AND EQUIPMENT PURCHASES

- 1 - Type of Machine
- 2 - Size or Capacity of Machine
 - A. Length
 - B. Width
- 3 - Fixed Cost
- 4 - Operating Cost
- 5 - Capital Requirements
- 6 - Labor Saved
- 7 - Adjusting the Equipment to
the Farm
 - A. New Machinery
 - B. Used Machinery

A FORMULA FOR DETERMINING THE NUMBER OF ACRES A MACHINE CAN WORK IN AN HOUR

W - WIDTH OF MACHINE IN FEET

S - SPEED OF TRAVEL (MPH)

E - EFFICIENCY FACTOR OF MACHINE

$$\frac{W \times S \times E \text{ 5280 ft./mile}}{43560 \text{ sq. ft./acre}} =$$

$$\frac{W \times S \times E}{8.25} =$$

Acres Per Hour

EXAMPLE: Machine Width = 16 ft.
Speed of Travel = 5.3 MPH
Efficiency Factor = .81

$$\frac{W \times S \times E}{8.25} =$$

$$\frac{16 \times 5.3 \times .81}{8.25} =$$

$$\frac{68.688}{8.25} =$$

8.3 Acres Per Hour

COSTS OF OWNERSHIP FOR LIVESTOCK AND FIELD EQUIPMENT

SOURCES OF COSTS	PERCENTAGE OF BASIS			
	LIVESTOCK EQUIPMENT		FIELD EQUIPMENT	
	New	Used	New	Used
Depreciation	10.00	20.00	10.00	20.00
Interest	4.25	4.25	4.25	4.25
Repairs	3.50	7.00	4.50	9.00
Taxes	1.00	1.00	1.00	1.00
Insurance	0.25	0.25	0.25	0.25
Storage	2.00	2.00	2.00	2.00
	21.00	34.50	22.00	36.50

FORMULA FOR SUBSTITUTING CAPITAL FOR LABOR

$$\frac{\text{LABOR SAVED} \times \text{COST PER HOUR}}{\text{HOURS OF PERCENTAGE COST OF OWNERSHIP}} = \text{AMOUNT OF CAPITAL TO SUBSTITUTE FOR LABOR}$$

EXAMPLE:

New Field Machine

Saves 420 Hours Per Year

Labor Cost \$4.00 Per hour

$$\frac{420 \times \$4.00}{.22} = \frac{\$1,680.00}{.22} = \$7,636.36$$

LEASING PERIODS, POSSIBLE RATES, AND FORMULA FOR EVALUATING LEASE

<u>LEASING</u> * <u>PERIOD</u>	<u>LEASING RATE</u> (% OF NEW COST)
1 Day (10 hrs.)	1
1 Week (6 days)	5
2 Weeks (12 days)	10
1 Month (4 weeks)	15
2 Months (8 weeks)	25
3 Months (12 weeks)	33
1 Year	10, 20, 30

LEASING FORMULA

$$\text{Use - Cost Rate} = \frac{\text{Total Finance Charge}}{\frac{1}{2} \text{ Unpaid Balance}} \times \frac{\text{No. of Payments}}{\text{Years}} \times \frac{1}{\text{No. of Payments} + 1}$$

$$\text{Rate} = \frac{2000 \text{ (Total Finance Charge)}}{3800 \text{ (}\frac{1}{2} \text{ Of Unpaid Balance)}} \times \frac{4 \text{ (No. of Payments)}}{4 \text{ (Years)}} \times$$

$$\frac{1}{4 + 1 \text{ (No. of Payments 1)}} = \frac{20}{38} \times \frac{1}{5} = \text{Rate} = 10.9$$

AGRICULTURAL MANAGEMENT

Unit D: Agricultural Planning

Topic 4: Investment Planning

Note: All terms underlined are included in the "Glossary of Terms."

1. Planning Family Investments

Social security and company sponsored retirement programs have helped some of our older citizens eliminate their dependency on families and government; however, statistics indicate that only one person in twenty-five is financially independent when he reaches sixty-five years of age. Providing for financial security in their old age should be one of the main objectives of all American families.

For many years farmers, being self-employed, were not able to participate in a retirement plan other than Social Security. In recent years the "Keogh Plan" or "HR10 Plan" has been made available to self-employed people. In general, this allows a self-employed person to set aside a limited amount of income for retirement, and defer payment of taxes on the amount set aside at a future date.

In order for most families to become financially secure, they must develop and follow a long-range investment plan. To develop the plan, the family should determine its objectives and means of accomplishing these objectives. No two families will have the same objectives or investment plans. The plan should be flexible to allow for adjustments as conditions change and certain objectives are met.

Transparency No. 1

Families go through about four stages or cycles. An understanding of the cycles may be helpful in investment planning. The first cycle encompasses about the first ten years. During this time, the family is usually increasing, thus causing a financial strain. Most of the income will be spent for living expenses, establishing a home, obtaining a business, or purchasing equipment in the case of farmers. However, insurance and savings programs should be established during this period.

In cycle number two, the second ten-year period, the children are in school and usually there has been no reduction in money needed. During this period, a family usually expands its business.

The third ten-year period is the time most debts are paid, and the family business may experience another expansion. The children in the family have completed their education and are no longer dependent on the family for support. During this period, as in all periods, the family's security should be kept in mind. Property titles, wills, and insurance should be kept in order.

The fourth cycle is the period during which most families make the largest percentage of their investments. However, regular savings should be made during all cycles.

To develop the investment plan, the family will have to look into the future. If needs are anticipated too far in advance, the predictions will be inaccurate. Factors to be considered in investment planning are listed in the following transparency.

Transparency No. 2

After the plan has been developed, an inventory should be made which includes all investments which contribute to the plan. Social security, insurance, and other assets should be included.

Transparency No. 3

The investment inventory should show the current family assets, amount being invested each year, present worth, value in case of breadwinner's death, and value at breadwinner's retirement. After reviewing the inventory, the family may wish to increase or decrease its investments in certain areas. An increase or decrease in certain investments may be needed in such areas as kinds and costs of insurance policies, social security benefits, and sources and cost of credit.

Many families find that income available after business and family expenses are deducted is not adequate to provide the protection they desire. If all areas included in the plan cannot be executed immediately, the family should decide the order in which investments will be made. Adjustments in the plan may be necessary in order to fit the funds available. The most important factor in following any investment plan is making periodic investments of a specified amount.

Each family should have accumulated an emergency fund, (checking account and/or a savings account in a bank or savings and loan institution) before it considers making certain types of investments. These funds should be available for a major emergency. A specific amount for an emergency fund cannot be set, but, the equivalent of two months pay is a good rule-of-thumb to follow.

2. Types of Investments

There are many ways a family can invest. Sometimes capital invested off the farm will give greater returns. Of the several types of investments available, some may be classified as safe investments, while others are classified as speculative. The following may be considered as safe investments:

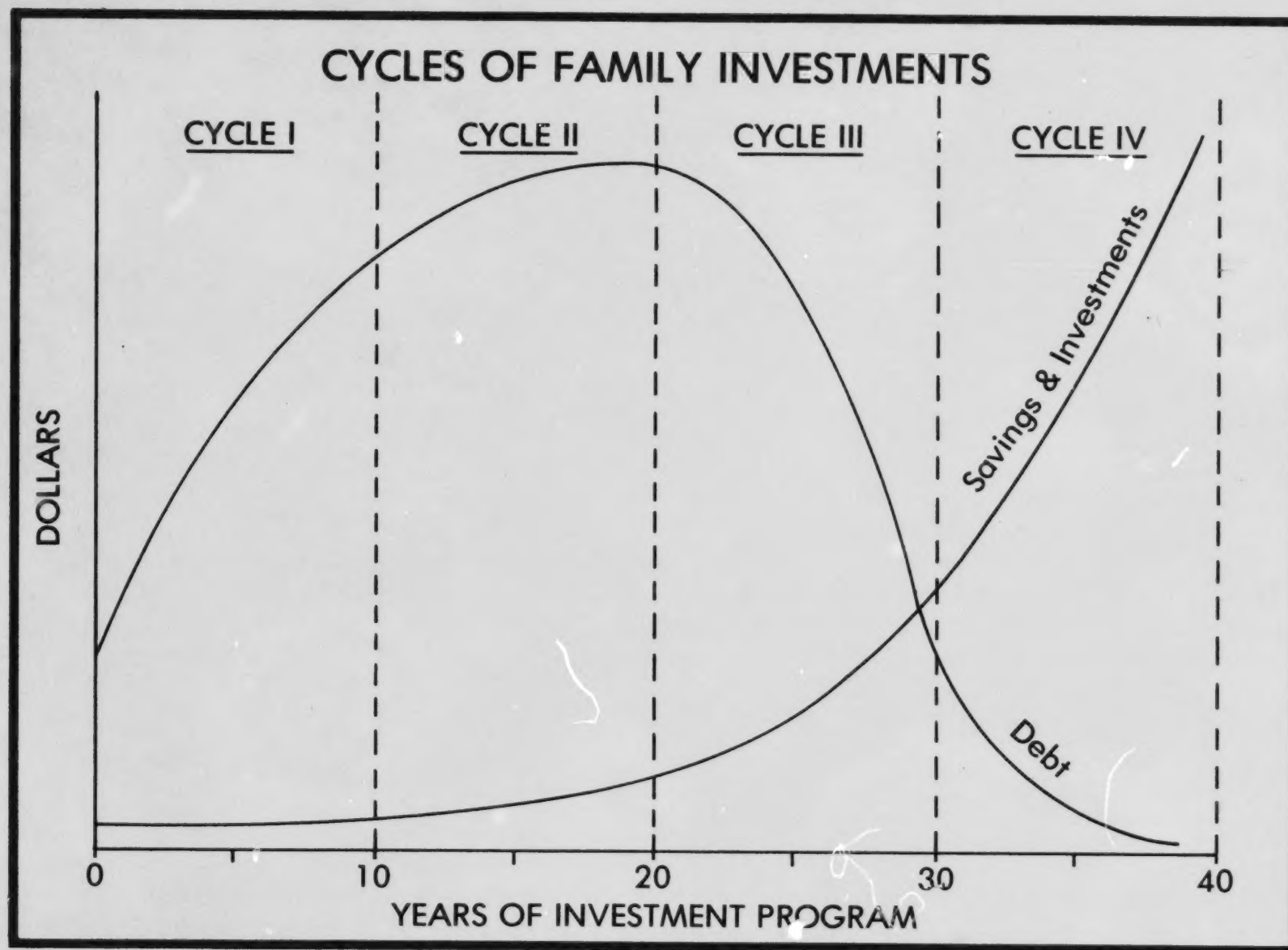
1. Savings department of a commercial bank
2. Savings and loan associations
3. Government savings bonds
4. Insurance
5. Certain kinds of stocks and bonds

A knowledge of certain kinds of investments is necessary before investing. An explanation of some types of investments follows.

Corporate securities - These include bonds, preferred stock, and common stock. A bond is a means whereby an individual lends money to a business on a fixed interest basis. This has priority over dividends to stockholders. The bond holder has more protection of his money but less opportunity for gain. The preferred stockholder has an investment in a corporation with a definite rate of dividends to be paid provided the company has sufficient earnings to make payments. Common stocks are the prime security in our economic system and are basic to the corporate form of business organizations. After the payment of all obligations, including bond holders and preferred stockholders, earnings go to owners of common stock. The dividend rate is dependent upon the earnings of the corporation.

Mutual funds - When shares are purchased in a mutual fund, one purchases interest in a portfolio of securities held by a corporation. Mutual fund shares provide the owner with a diversified investment and management services for his investment. The small buyer can purchase stock in a corporation that has a diversity of interests.

Real estate - The value of real estate has a tendency to adjust to economic conditions. Returns from real estate are influenced by local conditions, and the risk may be high. Some of the highest returns on investments have been from real estate. However, it may be unmarketable during periods of depressed prices.



FACTORS TO CONSIDER IN PLANNING INVESTMENTS

Size Of Family

Age Of Family Members

Investment Objectives

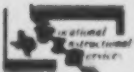
Present Means Of
Security And Protection

Additional Security Needed

Risks That Can Be Afforded

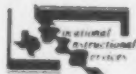
Condition Of Business

Family Income



INVESTMENT INVENTORY

WHAT WE HAVE NOW	WHAT WE ARE PUTTING INTO IT EACH YEAR	WHAT IT IS WORTH NOW	WHAT IT WOULD BE WORTH IN CASE OF THE DEATH OF THE BREADWINNER	WHAT IT WOULD BE WORTH AT RETIREMENT OF BREADWINNER
TOTAL	\$	\$	\$	\$



AGRICULTURAL MANAGEMENT

Unit E: Agricultural Records

Topic 1: Purposes and Types of Records

Note: All terms underlined are included in the "Glossary of Terms."

1. Importance of Farm Records

In the past farming was considered a "way of life." Today the modern farmer has to be a businessman, or he may not be able to enjoy his "way of life." Modern farmers and ranchers have several hundred thousand dollars invested in land, buildings, equipment, and livestock. These huge amounts of capital require that accurate records be kept.

Accurate records supply information that is necessary for sound management decisions. Some of the many uses of accurate records are given in the following transparency.

Transparency No. 1

2. Systems and Kinds of Agricultural Records

There are two methods or systems of keeping account books. One is the double entry system, while the other is known as the single entry system. Both systems are used by farmers, although the single entry system is the most often used.

To assist in determining the record system to use, a discussion is given on each. Using the double entry system, the farmer makes two entries for each transaction. For example, livestock sold for cash would reduce the livestock account and increase the cash account. Entries would be made in both accounts. The liabilities and assets are the same on the balance sheet if the double entry system is used. The double entry system is the most complicated but is very good for large, complicated farming operations. Errors are much easier to find with this system.

Transparency No. 2

There are several kinds of agricultural records; the kinds that the farmer keeps will be determined by what the farmer wants to know about his business. If all the farmer wishes to know is whether there was a profit or loss for a given year, the only record needed is an inventory record. However, if one is interested in knowing which farm enterprise made the most money, there will be a need to keep other records. Several different kinds of records are listed in the following transparencies.

After the farmer has determined the kinds of records he is going to keep, he will need to select a farm account book or record sheets for recording information. When selecting the record book or forms for keeping records, the farmer should base his selection on the format and the amount of time required to keep the records he is considering. The records should be in a form that will require a minimum amount of time. Most land-grant colleges, some equipment firms, and some local banks provide record books that may be used by farmers. These records may not fit a particular farm but they can be used as a valuable guide for developing the type of record that is needed. A knowledge of book-keeping would be helpful but is not necessary to keep accurate records. Having a desire to keep good records and spending the necessary time to keep them are the only prerequisites for keeping accurate records.

A brief explanation of each of the records listed in the above transparency is as follows:

Transparency No. 3

Enterprise Records - Enterprise records include the expense and/or income of each enterprise. In some farm account books, the expenses and income for several enterprises may be listed on a double-spread page, called column distribution; while some books provide a separate sheet for listing the expenses and income of each enterprise.

Transparency No. 4

Another type of form that may be used is the operating and capital expense record. This form may be used instead of an enterprise record. Notice that the above form shows only three enterprises; however, by extending the form additional enterprises may be included. If a purchase, such as feed, is made for one enterprise, an entry is made in the total expense column (col. 5) and the appropriate amounts are charged to the enterprise.

The income form is similar to the expense form and is used in the same manner.

Transparency No. 5

Labor Record - The labor record may be kept separately from the other records, or it may be included on the enterprise sheet or operating and capital expense sheet.

Transparency Nos. 6a and 6b

Inventory Records - These records may be kept in two ways. All farm items may be listed together on one form or several forms may be used, grouping similar items on each form. Using the latter method, the farmer or farm manager would usually maintain an inventory for crops, livestock and poultry,

land, buildings and permanent improvements, machinery and equipment. In this case, an inventory summary would be necessary to show the total of all inventories.

The inventory may be taken at any time during the year; however, it should be taken about the same time each year. The fiscal year for most farmers is Jan. 1 to Dec. 31. December would be a good month for these farmers to take their farm inventory.

Transparency No. 7

Depreciation Records - Since the different methods of figuring depreciation are covered in detail in another topic, this topic includes only the form that one might use to record depreciation.

Financial Records - The financial record, sometimes called the net worth statement, is a necessary record that should be kept by the farmer. The net worth statement is covered in detail in the next topic.

Transparency No. 8

Other Records - In addition to the records listed above, the farmer should keep insurance records (personal and property), medical expense records, contribution records, breeding records, and enterprise analysis records.

It is not uncommon to hear a successful businessman recite statistics, pertaining to his business, which were uncovered or found in the records of his business. Good records have probably influenced business decisions and procedures more than any other single factor. In the competitive business of farming, the keeping of accurate records is essential.

USES OF FARM RECORDS

A. LEGAL USES

1. Income Taxes
2. Social Security Taxes
3. Basis for dividing income according to business organization (Proprietorship, Partnership, Corporaton)

B. BUSINESS USES

1. Determine Net Income
2. Provide Control Over the Business
3. Improve Management
4. Determine the Profitable and Unprofitable Enterprises
5. Permanent Record of Past Years
6. Essential to Determine Operating Agreements
7. Basis for Farm Credit and Financing
8. Government Programs
9. Determine Production Efficiency Factors
10. Forward Planning

KINDS OF FARM RECORDS

- * Enterprise Records
- * Sales and Purchase Records
- * Labor Records
- * Inventory Records
- * Depreciation Records
- * Financial Records
- * Other Records

[illegible][illegible][illegible]

OPERATING AND CAPITAL EXPENSE FORM

DATE	EXPENSE ITEMS	QUANTITY AND UNIT	PRICE Per Unit	EXPENSE			
					ENTERPRISE		
1	2	3	4	5	1	2	3
	TOTALS BROUGHT FORWARD		\$	\$	\$	\$	\$
TOTALS				\$	\$	\$	\$

INCOME (CAPITAL AND NON - CAPITAL)

DATE	INCOME ITEMS	QUANTITY AND UNIT	PRICE Per Unit	INCOME			
					ENTERPRISE		
1	2	3	4	5	1	2	3
	TOTALS BROUGHT FORWARD		\$	\$	\$	\$	\$
TOTALS				\$	\$	\$	\$

LABOR RECORD

FIELD 1			CROP OATS			ACRES 25			YEAR 1982		
PLOW & DISC			PLANTING			HARVEST			HAULING		
Date	Hours		Date	Hours		Date	Hours		Date	Hours	
	Man	Tractor		Man	Tractor		Man	Combine		Man	Pickup
8/7	9	9	9/16	12	10	7/7	10	8	7/7	15	15
8/8						7/8	10	8			
Total			Total			Total			Total		

INVENTORY FORMS

Crop

Beginning of Year

End of Year

ITEM	UNIT	QUANTITY	UNIT PRICE	VALUE	QUANTITY	UNIT PRICE	VALUE
corn	bushels	100	\$3.00	\$300.00	40	\$3.00	\$120.00

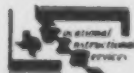
Livestock

KIND AND NUMBER	SOURCE		DATE PURCHASED	VALUE	YEARS DEPRECIATION	DEPRECIATION PRIOR YEARS	DEPRECIATION THIS YEAR	PRESENT VALUE
	Pur-chased	Raised						
cows (10)	*		1/15/83	\$1500.00	7	none	none	\$1500.00

Machinery

KIND AND NUMBER	DATE PURCHASED	COST	SALVAGE VALUE	YEARS DEPRECIATION	DEPRECIATION FOR THIS YEAR	VALUE 1982	
						Begin	End
tractor	5/15/82	\$4550.00	\$325.00	10	\$246.40		\$4303.60

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INVENTORY FORMS

Land

TYPES OF LAND	BEGINNING OF YEAR		END OF YEAR	
	ACRES	VALUE	ACRES	VALUE
Cropland	300	\$90,000.00	300	\$90,000.00
Pasture, open	200	\$60,000.00	300	\$60,000.00
Pasture, wooded	200	\$40,000.00	200	\$40,000.00
Barnyard and home	3	\$900.00	3	\$900.00

Summary

KIND OF INVENTORY	TOTAL VALUE	
	BEGINNING	ENDING
Crops	\$100.00	\$40.00
Livestock	\$1500.00	\$1500.00
Machinery		\$4303.60

A FIVE YEAR DEPRECIATION FORM

Line No.	Description	Date Acquired	Cost or Other Basis		Depreciable Balance		Estimate Life Years	Method Used
	barn	1/8/80	\$7,800	00	\$7,800	00	25	straight line
	fences	1/8/80	\$1,600	00	\$1,600	00	5	ACRS
	tractor	6/27/80	\$26,000	00	\$26,000	00	5	ACRS

Rate (%)			1981				1982			
1st Year	2nd Year	3rd-5th Years	Prior Depreciation		Depreciation This Year		Prior Depreciation		Depreciation For This Year	
3.12 each year			\$312	00	\$312	00				
.15	.22	.21	\$240	00	\$352	00				
.15	.22	.21	\$3900	00	\$5,720	00				

FORMS FOR KEEPING OTHER RECORDS

PROPERTY INSURANCE RECORD

Date of Policy	Policy No.	Company	Property Insurance	Amount	Term	Expiration Date	Premiums	
							Amount	Due
1/1/80	35689	farm	home	\$25,000.00	three years	1/1/83	\$130.00	1/1/80

MEDICAL EXPENSES

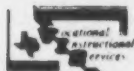
Date	Payee	Service	Amount Paid	Miles	Mileage
9/15/82	Dr. John Brown	physical examination	\$35.00	30	1.50

CONTRIBUTIONS

CHURCH		CHARITABLE ORGANIZATION			DUES and FEES		
Date	Amount	Name	Date	Amount	Name	Date	Amount
1/24/82	\$25.00	United funds	3/15/82	\$25.00	club	1/1/82	\$5.00

LIFE INSURANCE

Company	Policy		Kind and Terms	Amount	Beneficiary	Premiums	Date Due
	Date	No.					
National	1/14/80	56709	ordinary life	\$10,000.00	mother	\$40.00	1/14/81



AGRICULTURAL MANAGEMENT

Unit E: Agricultural Records

Topic 2: Depreciation

Note: All terms underlined are included in the "Glossary of Terms."

1. Introduction to Depreciation

The Economic Recovery Act of 1981 changed many of the regulations and procedures used by farmers and ranchers in calculating depreciation. Prior to the new law, an Asset Depreciation Range (ADR) System was used. The ADR was based on a depreciable item's useful life. The new law replaces this system with the Accelerated Cost Recovery System (ACRS). Under ACRS, the cost or other basis of a depreciable asset is recovered in a specific period of time. In most instances, the write-off periods under the new system are substantially shorter than the useful life under the prior law. The Asset Depreciation Range System is terminated for assets placed in service after 1980 and is replaced with the ACRS.

Transparency No. 1

The recovery periods under the ACRS are 3 years, 5 years, 10 years, and 15 years. Shown in the above transparency are recovery periods for several different kinds of assets.

Transparency No. 2

In order to understand depreciation regulations, it is essential that managers know the meanings of certain terms. Definitions of some of the more commonly used terms are given below:

Adjusted Basis - The remaining value of a depreciable item after subtracting the value of a trade-in, or the amount to be depreciated after subtracting the amount taken for investment credit.

Basis - The acquisition cost or value of an item. In case of an outright purchase, the basis is the price paid.

Expensing - Means immediate deducting the expense of tangible personal property. The total amount that may be expensed will be phased in over a 5-year period.

Capital Item - The term used for items which are eligible for depreciation. Tractors, equipment, livestock, and single purpose buildings are examples.

New Nonresidential Real Property - New nonresidential buildings used in the farm or ranch business.

Personal Property - This is probably self-explanatory. Livestock, equipment, etc. are classed as personal property.

Real Property - Land, land improvements, and buildings are classified as real property.

2. Methods of Depreciation

Transparency No. 3

Personal Property - Annual depreciation deductions for personal property are determined by applying a statutory percentage to the unadjusted basis (actual cost or basis) of the property. See Figure 1 in the above transparency. The statutory percentages shown in Figure 1 of above transparency for the years 1981-84 is equal to a 150-percent declining-balance method, which could be used prior to the new Act for calculating depreciation. For 1985, the statutory percentage is equal to the 175-percent declining-balance method; and in 1986 and thereafter, it equals to the 200-percent declining-balance method. Although the declining-balance method of calculating depreciation may not be used for property placed in service after 1980, the formula for its use is shown in the transparency which illustrates the straight-line method of calculating depreciation.

Real Property - Depreciation deductions for real property are based on the 175-percent declining-balance method with a switch to straight-line. Also, teachers should be aware that real property is depreciated on the basis of the number of months it is actually in service during the tax year. The recovery period for real property is generally 15 years. IRS Publication 534 contains a table showing the percentages taken based on the month placed in service.

The full cost or basis is depreciable under ACRS; and regardless of the time of year in which an item was purchased, one-half year's depreciation may be taken.

Transparency No. 4

In addition to a specific time period at a specific rate, taxpayers have the option to use one of two recovery periods provided for each class of property. The optional recovery periods are shown in the above transparency.

Also, the taxpayer may elect to use the straight-line method of depreciation rather than an accelerated method over any of the recovery periods. This provides some flexibility for the taxpayer.

The taxpayer should be aware that ACRS will not apply if he/she uses a method of depreciation which is not expressed in terms of years. Also, the taxpayer is prevented from converting personal property owned or used by the taxpayer prior to 1981 to the ACRS.

Calculating Depreciation by the Various Methods

If the ACRS is used, the statutory percentage allowed for the class of property is multiplied by the unadjusted basis.

Using the straight-line method of depreciation, the basis is divided by the number of years of useful life.

Although the declining-balance method of calculating depreciation may not be used on property purchased in 1981 and thereafter, it still may be used on property placed in service prior to 1981. Its use is also mentioned in the above discussion. Either 150, 175, or 200 percent could be used, depending upon the property and whether it was new or used.

3. Recapture of Depreciation Deductions

Gain on the sale or disposition of personal property is treated as ordinary income rather than capital gain on prior depreciation deductions taken.

Gain on the sale or disposition of real property should be treated as ordinary income rather than capital gain only to the extent that depreciation taken exceeded that which would be allowed under the straight-line method of depreciation. The recapture treatment will also be treated in the same manner if the straight-line method of depreciation is used. However, if an accelerated method of depreciation is used, all gain to the extent of prior depreciation taken will be treated as ordinary income.

4. Investment Tax Credit

The principal types of farm property which qualify for investment tax credit are farm machinery, equipment, livestock, and certain single-purpose agricultural or horticultural structures.

Investment credit for eligible property with a 3-year recovery period is 6 percent; and eligible property with a recovery period of 5, 10, or 15 years is 10 percent.

The maximum investment credit for any tax year is the tax liability for that year or \$25,000 plus 90 percent of the tax liability in excess of \$25,000, whichever is less. Also, the carryover period is 15 years (investment tax credits can be carried forward for 15 years).

Fifteen-percent credit is allowed on the rehabilitation of structures at least 30 years old, and a 20-percent credit may be taken for the rehabilitation of structures at least 40 years old. To qualify for the credit, the structure must be substantially rehabilitated. Also the expenditures during the 24-month period ending on the last day of the taxable year must exceed the greater of the adjusted basis of such property or \$5,000. The accelerated methods of depreciation may not be used for such expenditures. In addition, the basis of such property improvements for depreciation purposes must be reduced by the amount of the credit. Thus, a farmer who receives a 20-percent credit for rehabilitation expenditures on the rehabilitation of a 40-year-old structure will be allowed to depreciate only 80 percent of the cost of such expenditures.

5. Expensing

Until the passage of the Economic Recovery Act of 1981, there were no special provisions which provided small businesses the option to expense (immediately deduct) the cost of certain types of property. New or used personal property may be expensed in the amount of \$5,000 in 1982 and 1983, \$7,500 in 1984 and 1985, and \$10,000 for each year after 1985. Expensed property is not eligible for investment tax credit. Also, expensed property will be ineligible for the deferral of gain under an installment sale. Any gain on the installment sale of such property must be immediately recognized.

DEPRECIATION PERIODS UNDER ACCELERATED COST RECOVERY SYSTEM

Asset	Recovery Period
	YEARS
FARM MACHINERY, EQUIPMENT, GRAIN BINS, AND FENCES BUT NO OTHER LAND IMPROVEMENTS	5
COTTON GINNING ASSETS	5
CATTLE, BREEDING OR DAIRY	5
HORSES, BREEDING OR WORKING <u>a/</u>	5
HOGS, BREEDING	3
SHEEP AND GOATS, BREEDING	5
FARM BUILDINGS	15
SINGLE-PURPOSE STRUCTURES	5
<u>a/</u> Racehorses over 2 years old and other horses over 12 years old placed in service by the taxpayer are included in the 3-year class.	

DEPRECIATION TERMS

Adjusted Basis

Basis

Expensing

Capital Item

New Non-residential Real Property

Personal Property

Real Property

ANNUAL DEPRECIATION DEDUCTIONS

For Property Placed In Service After Dec. 31, 1980 And Before Jan. 1, 1985

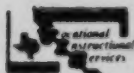
RECOVERY YEAR	TYPE OF PROPERTY		
	3 Year	5 Year	10 Year
1	25	15	8
2	38	22	14
3	37	21	12
4	—	21	10
5	—	21	10
6	—	—	10
7	—	—	9
8	—	—	9
9	—	—	9
10	—	—	9

For Property Placed In Service In 1985

RECOVERY YEAR	TYPE OF PROPERTY		
	3 Year	5 Year	10 Year
1	29	18	9
2	47	33	19
3	24	25	16
4	—	16	14
5	—	8	12
6	—	—	10
7	—	—	8
8	—	—	6
9	—	—	4
10	—	—	2

For Property Placed In Service After 1985

RECOVERY YEAR	TYPE OF PROPERTY		
	3 Year	5 Year	10 Year
1	33	20	10
2	45	32	18
3	22	24	16
4	—	16	14
5	—	8	12
6	—	—	10
7	—	—	8
8	—	—	6
9	—	—	4
10	—	—	2



OPTIONAL DEPRECIATION RECOVERY PERIODS AND METHODS OF CALCULATING DEPRECIATION

ASSET CLASS	OPTIONAL PERIODS
	<u>Years</u>
3 - year	5 and 12
5 - year	12 and 25
10 - year	25 and 35
15 - year	35 and 45

ACRS

Example: A piece of equipment with a basis of \$10,000

$$\$10,000 \times .15 = \$1500.00 \text{ First year's depreciation}$$

Straight-Line Method

Example: A piece of equipment with a basis of \$10,000 and a useful life of 12 years

$$\$10,000 \div 12 = \$833.33 \text{ First year's depreciation}$$

Declining-Balance Method

$$\text{Formula: Adjusted Balance} \times \frac{1.5, 1.75, \text{ or } 2.0}{\text{Useful Life}} = \frac{\text{Annual}}{\text{Depreciation}}$$

Example: A piece of equipment with a basis of \$10,000

$$\$10,000 \times \frac{2}{10} = \$2,000 \text{ First year's depreciation}$$

AGRICULTURAL MANAGEMENT

Unit E: Agricultural Records

Topic 3: Formulating Income and Financial Statements

Note: All terms underlined are included in the "Glossary of Terms."

1. Income Statement

At the end of the fiscal year, the farmer or farm manager should review his records, discussed in Topic E-1, and compile from them a farm income statement.

Transparency No. 1

The income statement includes a list of all the farm expenses, which include debits and receipts or credits. These figures are taken from the enterprise, labor, purchase and sales, and other records kept by the farmer. The income statement is divided into expense and income columns and adjustments for change in inventory. The credit or income side may have several headings; but most farm receipts can be listed under the heading of livestock and livestock products, crops, and other farm receipts. Similar items should be grouped on the income statement so that the farmer can readily see the income received from different enterprises. The expense side of the income statement may have several headings also; but most farm expenses can be listed under operating expenses and depreciation. Capital investments are listed in the inventory section.

Operating expenses are expenses incurred in production and are usually expended in one year or on one crop, while fixed expenses are rather stable. An increase or decrease in fixed expenses is not affected by production. Depreciation, interest, repairs, taxes, insurance, and cash rent are fixed expenses. Depreciation expense is represented by the net change for each type of capital item.

In order to determine net cash income, the farmer subtracts the total operating expenses (2) from the total farm receipts (1). The net farm income is remaining after adding or subtracting the net cash income (3), net charge of current assets (4) and net change of intermediate and long-term assets (6). Off-farm income (8) is added to net farm income (7) to determine the total income available (9). Family living expenses and income taxes (10) are subtracted from total income available (9) to determine retained farm earnings (11). Retained farm earnings is the amount of money available for debt repayment and farm expansion.

Transparency No. 2

The annual income statement should have more meaning when compared with previous year's statements. It would be advantageous to the farmer to compare his income statement with that of a farm similar to his. This, however, may be difficult to do.

2. Financial Statement

The financial statement is a statement that shows the net worth of an individual or business. Each person and business should prepare an annual net worth statement to determine if his equity or ownership is increasing or decreasing. A finance statement is usually required by the lending institution when a person borrows money.

Transparency No. 3

The finance statement is divided into two parts, assets and liabilities. Assets (farm inventory, cash, and accounts receivable) are valuable items in the farm business. They may be in the form of a claim against something of value held by someone else. There are two kinds listed in the above transparency, and most items of value may be listed under fixed assets, or current assets.

A liability is a claim against the farm and may include accounts payable, notes payable, mortgages, and other debts. Liabilities are of three kinds: long-term, intermediate, and current.

Long-term liabilities are liabilities that take several years to pay and may run as long as thirty years. Intermediate liabilities are due in the future and usually run for one to seven years. Current liabilities are due immediately and are usually made when feed and supplies are purchased.

The financial statement may be compiled without too much difficulty; however, the increase in the value of assets over a period of time might cause the farmer a problem in determining his net worth. If the farmer reevaluates his long-term assets and lists their true value in the net worth statement, he will have a paper income but not an income that can be withdrawn. On the other hand, however, if the true values of these assets are not listed, his true net worth will not be shown and the security of his business will be understated. Possibly, the best way to show an increase in the net worth of long-term assets without affecting the farm business would be for the farmer to adjust the value of long-term assets between accounting periods. The values on the inventory of the preceding year are adjusted before the current inventory is taken. In other words, the same value would appear on both inventories (beginning and ending). A farmer may wish to make these changes every three to five years.

Transparency No. 4

A comparative finance statement is helpful in comparing the growth in net worth over a period of years.

3. Measuring Financial Success

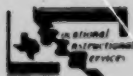
The net worth statement will give the farmer's equity in the farm, but it may be necessary to examine the relationship that exists between certain assets and liabilities. This is usually expressed in terms of ratios. In fact, the safety or degree of safety of a business is usually expressed in the terms of ratios. The capital ratio is found by dividing the assets by the liabilities. As an example, a farmer with assets of \$40,000 and liabilities of \$20,000 would have a capital ratio of 2:1. It is rather easy after this ratio is computed to determine the amount the assets would have to decline for the liabilities to exceed the assets. With a favorable capital ratio, a farmer will find it much easier to borrow money. It is difficult to recommend a safe ratio, as the type of farming and other factors such as risk and uncertainty would influence the safety of a ratio.

References:

1. Beneke, Raymond R., Managing the Farm Business, John Wiley and Sons, New York, 1955.
2. Heady, Earl O. and John A. Hopkins, Farm Records and Accounting, Iowa State University Press, Ames, Iowa, 1962.

INCOME STATEMENT

OPERATING RECEIPTS			OPERATING EXPENSES	
ITEM	UNITS	\$	ITEM	\$
From Sale Of Livestock Prod.			feed purchase	4,600
steers	80	31,200	auto and truck exp.	1,740
			livestk. exp.(breed, vet., etc.)	250
Subtotal Livestock		31,200	seeds and plants	900
			fertilizer and chemicals	3,600
From Sale Of Crops			machine repair	1,800
cotton	120 bales	14,400	fuel and oil	2,000
wheat	2,200 bu.	2,640	hired labor	4,100
milo	900 cwt.	1,530	rent	4,500
Subtotal Crops		18,570	utilities (farm share)	900
			taxes	4,000
Other Farm Receipts			insurance	1,200
government payment		12,300	interest	5,850
other			miscellaneous supplies	1,050
Subtotal Other		12,300		
			TOTAL OPERATING EXPENSES (2)	36,490
TOTAL FARM RECEIPTS (1)		62,070		
			NET CASH INCOME (3)	25,580
ADJUSTMENTS FOR CHANGE IN INVENTORY:				
	Feed	Market Livestock	Crops	Supplies
beginning inventory	\$2,100	\$12,400	\$3,100	\$1,100
closing inventory	4,500	13,700	3,300	1,000
Net change (±)	\$+2,400	\$+1,300	\$+200	\$-100
			(4) (±)	3,800
			Net operating profit (5)	29,380
ADJUSTMENT FOR CAPITAL ITEMS:				
	Machinery And Equipment	Improvements	Breeding Livestock	
beginning inventory	\$28,500	\$15,000	\$42,650	
plus purchases	5,500			
less sales			3,330	
less ending inventory	30,000	14,000	44,800	
Net change (±)	\$-4,000	\$-1,000	\$5,480	(6) (±) 480
			NET FARM INCOME	(7) 29,860
			OFF-FARM INCOME	(8) 110
			TOTAL INCOME AVAILABLE	(9) 30,970
			WITHDRAWN FOR FAMILY LIVING & INCOME TAXES	(10) 11,870
			RETAINED FARM EARNINGS	(11) 18,100



COMPARATIVE INCOME STATEMENT

OPERATING RECEIPTS	1978	1979	1980
livestock - - - - -	\$24,870	\$31,200	\$27,600
crops - - - - -	15,700	18,570	21,150
other - - - - -	12,000	12,300	15,800
Total Farm Receipts	\$52,570	\$62,070	\$64,550
TOTAL OPERATING EXPENSES	-\$33,830	-\$36,490	-\$42,816
net income from operation - - - - -	\$18,740	\$25,580	\$21,734
inventory change—liquid assets - - - - -	-750	3,800	1,900
inventory change—capital items - - - - -	3,125	480	-4,700
PROFIT (loss) FROM OPERATION	\$21,115	\$29,860	\$18,934
off-farm income - - - - -	670	110	-0-
total income available	21,785	29,970	18,934
family living and income taxes - - - - -	-7,875	-11,870	-8,019
RETAINED FARM EARNINGS	\$13,910	\$18,100	\$10,915

THE FINANCE STATEMENT

Statement Date January 1, 1974

ASSETS

Current Assets

Cash on Hand and in Bank	\$ 500
Accounts and Notes Receivable	
Livestock Held for Sale	43,700
Crops Held for Sale	3,300
Feeds	4,500
Supplies	1,000
Other	

Total Current Assets \$ 53,000

Fixed Assets

Breeding Livestock	48,000	
Less Reserve for Deprec.	3,200	
Machinery	48,500	44,800
Less Reserve for Deprec.	20,500	
Buildings	27,000	28,000
Less Reserve for Deprec.	15,000	
	12,000	
Farm Land		192,000
Total Fixed Assets		\$276,800
Total Assets (1)		\$329,800

LIABILITIES AND NET WORTH

Current Liabilities

Accounts Payable	\$ 4,000
Note Due at Bank	4,500
Accrued Payroll Taxes	300
Current Portion Machinery Note	1,500
Current Portion Mortgage Note	6,000

Total Current Liabilities \$ 16,300

Fixed Liabilities

Mortgage (less current portion)	\$ 54,000
Machinery Note (less current portion)	2,500

Total Fixed Liabilities \$ 56,500

Total Liabilities (2) 72,800

Net Worth (3) 257,000

Total Liabilities and Net Worth \$329,800

COMPARATIVE FINANCE STATEMENT

ASSETS		1978	1979	1980
total current assets		\$50,000	\$53,000	\$59,750
total fixed assets		263,800	276,800	278,500
Total Assets		\$313,800	\$329,800	\$338,250
LIABILITIES				
total current liabilities		\$12,890	\$16,300	\$17,000
total fixed liabilities		61,700	56,500	52,500
Total Liabilities		\$74,590	\$72,800	\$69,500
NET WORTH		\$239,210	\$257,000	\$268,750
TOTAL LIABILITIES & NET WORTH		\$313,800	\$329,800	\$338,250

AGRICULTURAL MANAGEMENT

Unit E: Agricultural Records

Topic 4: Income Tax Returns

Note: The Teaching Taxes Program Kit, provided by the Internal Revenue Service, contains a list of terms used by the IRS. Terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities: The amount of class time allocated to this topic by the "Basic Curriculum Guide for Production Agriculture in Texas" prevents a detailed explanation of the federal income tax. Since it appears that income taxes will continue to be the principal source of revenue for the Federal government and that most individuals will be required to pay them, teachers of vocational agriculture may desire to spend "Local Adaptation" time to make a comprehensive study of income taxes.

The Internal Revenue Service will provide gratis a Teaching Taxes Program Kit, which includes all the materials needed to teach income taxes. The kit contains publications, student texts, forms for each class member, lesson plans, and transparency masters. To complement the kit, limited numbers of 16 millimeter films are also available.

These materials, including films, may be secured by writing or calling the Teaching Taxes Coordinator at any Internal Revenue Service district office.

1. Taxes and History

Taxes in the United States follow very closely the history of the country. At one time, the citizens of this country did not have a voice in the amount of tax, or where the tax revenue would be spent. The American Revolution was fought because the citizens did not have a voice in tax matters. Some consider the tax paid by New Englanders in 1646 on certain occupations as the forerunner of the income tax. The tremendous cost of the Civil War which began in 1861 made it necessary for the federal government to devise some system of taxation to raise money. In July 1862, President Lincoln signed into law a bill which taxed incomes, public utilities, occupations, and other items. The law also provided a permanent tax collecting agency, the Bureau of Internal Revenue, the forerunner of the Internal Revenue Service. After the end of the war, the need for revenue declined, and the income tax law was repealed.

The legality of the Federal government to tax incomes is questioned by some people today as it was during the Civil War. The Sixteenth Amendment to the Constitution, which was passed in 1909 and ratified by two-thirds of the states by 1913, provided the Federal government authority to levy and collect taxes on incomes.

The revenue from income taxes has increased as agricultural and industrial developments have progressed. Income tax receipts were one billion dollars in 1917, while in 1981 individuals paid \$285.6 billion and corporations paid \$61.1 billion in income taxes. Other Federal government income was as follows: Social security and other insurance and retirement taxes, \$186.4 billion; excise taxes, \$40.8 billion; and Federal Reserve deposits, custom duties, estate and gift taxes, and miscellaneous receipts, \$28.7 billion.

Transparency No. 1

Attention is directed to the expenditures for human resources, which amounts to over one-half of the Federal budget.

2. Filing Income Tax Return

The income tax system in the United States is based on voluntary compliance. Voluntary compliance places the responsibility for filing an income tax return on the individual. The individual must also determine his/her amount of tax liability.

The following chart, based on filing status, shows the minimum amounts of gross income that must be received in 1981 before a return is required to be filed:

Single	\$3,300
Single (age 65 or older)	4,300
Married, filing a joint return	5,400
Married, filing a joint return (one spouse age 65 or older)	6,400
Married, filing a joint return (both spouses age 65 or older)	7,400
Married, filing a separate return	1,000
Surviving spouse (Qualifying widow(er) with dependent child)	4,400

In addition, a person must file a return if any of the three following requirements apply:

1. Received tips from which social security tax was not withheld, even if gross income was less than \$3,300;
2. If a person is in business for himself/herself and had net earnings of \$400 or more from that business. This is called self-employment income; or
3. A person has unearned income of \$1,000 or more, such as dividends or interest, and can be claimed as a dependent by parent(s).

3. The Employee's First Job

The federal income tax system operates on a pay-as-you-go basis. This means as one receives money that is subject to income tax, the tax must be paid. It is the responsibility of the employer to withhold the tax from the employee's pay

and deposit it with the Government.

The Internal Revenue Service provides tables for employers' use in determining the amount of tax to withhold each pay period. The amount of tax withheld will depend upon income, marital status, and the number of exemptions or allowances claimed on Form W-4.

Transparency No. 2

The employee is required to complete a Form W-4 each time a new job is taken. Also, a Form W-4 must be completed for the same employee when conditions change that would affect income tax liability. For example, if the number of allowances claimed decreases or if the employee thinks he/she will have a tax liability. The new Form W-4 must be filed within 10 days from the time conditions change.

An employer will not withhold income tax from pay if the employee claims an exemption from withholding. An exemption may be claimed if the employee had no tax liability last year and does not expect to have income tax liability this year. This is especially helpful to students who usually work at part-time or vacation jobs and do not earn enough money to have to pay an income tax.

4. Wages and Tax Statement

Form W-2 is a record of the wages an employee was paid, the amount of Federal income tax withheld, amount of social security tax withheld, and the wages, tips, and other pay received.

The Wage and Tax Statement, Form W-2, is prepared by the employer. If an employee works until the end of the year, the employer is required to send the Form W-2 to the employee by January 31 of the following year. If the employee works only a part of the year, the employer may send the Form W-2 shortly after the employee leaves the job.

Transparency No. 3

If an employee fails to receive a Form W-2 by February 15, he/she should call the Internal Revenue Service number for the area and report same. Should an employee receive a Form W-2 with an incorrect entry, the employer should be requested to issue a corrected Form W-2. On the corrected copy the correction block under No. 5 should be checked.

Four copies of the Form W-2 are completed by the employer. Copy A is sent to Social Security Administration by employer; copy B is filed with tax return; copy C is for employee's record; and one copy is filed with tax return in those states having state income taxes. Also, the employer retains a copy.

5. Factors for the Beginning Taxpayer to Consider

The beginning taxpayer should determine the kinds of records to be kept, accounting period, and accounting method to be used. The records necessary to analyze the farm or any other business can be used for computing income taxes. However, to accurately determine income and compute income taxes, records must be accurate.

Accounting Periods

The taxpayer may use either of two accounting periods, calendar year or fiscal year. The calendar year, used by most taxpayers, is a 12-month period from January 1 through December 31. The fiscal year is a 12-month period and may end on the last day of any month except December. A taxpayer must choose the accounting period when filing the first income tax returns. To change the period, approval must be secured from the Internal Revenue Service.

Accounting Methods

The purpose of any accounting method is to reflect income and expenses accurately. The two methods of accounting used by taxpayers are the cash method and the accrual method. When using the cash method, the taxpayer reports all items of income in the year in which they are received, or they are credited to his/her account and are made available on demand. Farm expenses are deductible only in the tax year in which they are paid. The taxpayer, using the accrual method of accounting, credits income to the year in which it was earned, whether it has been received or not; and expenses are deducted when they are incurred rather than when they are paid.

With consent of the Commissioner of Internal Revenue Service, a farmer may use the crop method of accounting. This is used for crops that require more than twelve months between planting and harvesting.

Income Tax Forms

Many taxpayers have a choice as to which form, Form 1040 A or Form 1040, is used for filing returns. These forms are often referred to as the short form and the long form. The Form 1040 A is the simpler form. It may be used if all income is from wages, salaries, tips, other employee compensations, and interest and dividends.

There are, however, deductions and credits that cannot be claimed on Form 1040 A that can be claimed on Form 1040. Form 1040 requires the taxpayer to itemize deductions. Several sheets make up this form. After filing the first income tax return, the IRS generally mails the proper form, with instructions, to the taxpayer.

April 15 is the due date on which most taxpayers must file their returns if they file on the basis of a calendar year, January 1 - December 31. Should April 15 fall on a Saturday, Sunday, or legal holiday, the taxpayer may mail the return the next day.

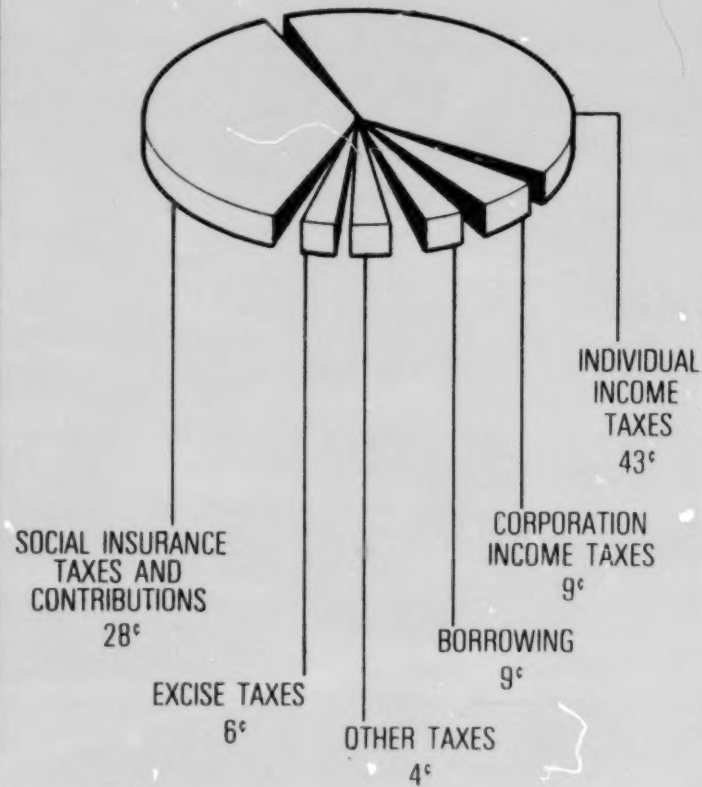
The income tax return is mailed to the regional IRS. The address of the regional office is listed on the instructions. Also, a self-addressed envelope is included with the form and instructions mailed to taxpayers.

Reference:

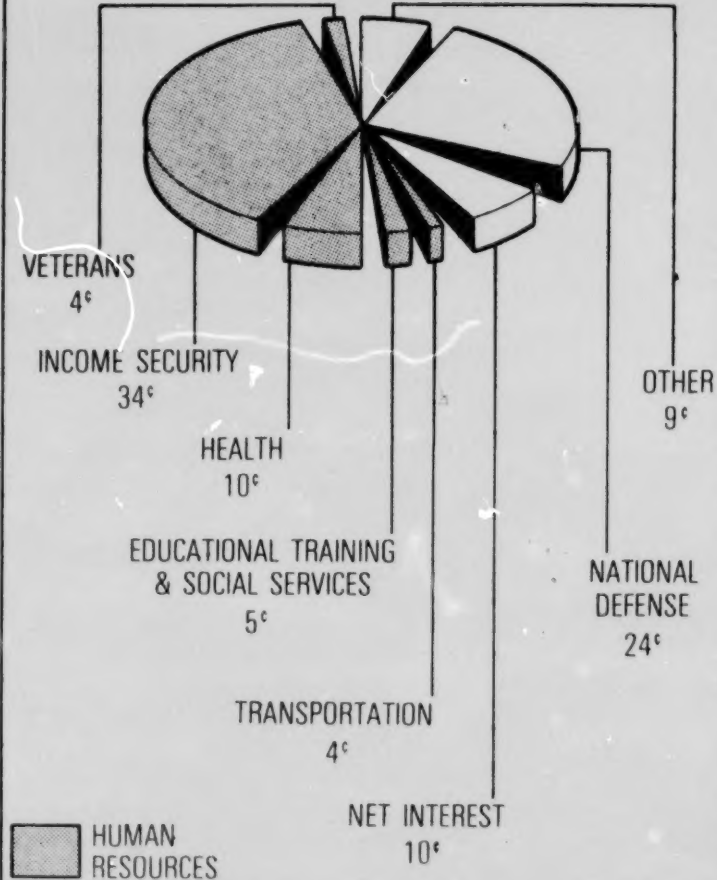
"Understanding Taxes 1981," Internal Revenue Service, Washington, D.C.

GOVERNMENT REVENUE AND EXPENDITURES 1981

SOURCE OF EACH DOLLAR OF REVENUE



EACH DOLLAR OF EXPENDITURES WAS AS FOLLOWS



EMPLOYEE'S WITHHOLDING ALLOWANCE CERTIFICATE

FORM W-4

Form W-4 (Rev. October 1979)	Department of the Treasury-Internal Revenue Service Employer's Withholding Allowance Certificate		
Print your full name ▶ <u>Robert T. Forest</u>		Your social security number ▶ <u>089 65 6125</u>	
Address (including ZIP code) ▶ <u>123 Main St. Skiville, New Hampshire 03801</u>			
Marital status: ☒ Single ☐ Married ☐ Married, but withhold at higher Single rate Note: If married, but legally separated, or spouse is a nonresident alien, check the single block.			
1 Total number of allowances you are claiming (from line F of the worksheet on page 2).		\$ 2	
2 Additional amount, if any, you want deducted from each pay (if your employer agrees).			
3 I claim exemption from withholding because (see instructions and check boxes below that apply):			
a ☐ Last year I did not owe any Federal income tax and had a right to a full refund of ALL income tax withheld, AND b ☐ This year I do not expect to owe any Federal income tax and expect to have a right to a full refund of ALL income tax withheld. If both a and b apply, enter "EXEMPT" here ▶ c If you entered "EXEMPT" on line 3b, are you a full-time student? ☐ Yes ☐ No			
Under the penalties of perjury, I certify that I am entitled to the number of withholding allowances claimed on this certificate, or if claiming exemption from withholding, that I am entitled to claim the exempt status.			
Employee's signature ▶ <u>Robert T. Forest</u>		Date ▶ <u>6/21</u> , 19 <u>81</u>	
Employer's name and address (including ZIP code)(FOR EMPLOYER'S USE ONLY)			Employer identification number

----- Detach along this line -----

WAGE AND TAX STATEMENT

FORM W-2

1. Control number				3 Employer's identification number 32-8876345		4 Employer's State number	
2. Employer's name, address, and ZIP code Super Service Station 702 Main Street Goodtown, OH 45201				5 Stat. em- De- Pension Legal 942 Sub- Cor- Void ployee ceased plan rep. emp. total rection			
				☐ ☐ ☐ ☐ ☐ ☐ ☐			
				6		7 Advance EIC payment	
8. Employee's social security number 499-65-8529		9. Federal income tax withheld \$17.20		10 Wages, tips, other compensation \$2,250.00		11 FICA tax withheld \$149.63	
12 Employee's name, address, and ZIP code Joseph K. Day 615 Poplar Drive Goodtown, OH 45201				13 FICA wages \$2,250.00		14 FICA tips	
				15 Employer's use			

Form W-2 Wage and Tax Statement 1981

Copy B To be filed with employee's FEDERAL tax return
This information is being furnished to the Internal Revenue Service.

Department of the Treasury
Internal Revenue Service

AGRICULTURAL MANAGEMENT

Unit E: Agricultural Records

Topic 5: Social Security

Terms: All terms underlined are included in the "Glossary of Terms."

Suggested Procedure and Activities: The teacher of vocational agriculture should have students who do not have social security numbers to apply for them. Cards may be obtained at a social security office.

1. Introduction to Social Security

In the early history of the United States, a large percentage of the population made their living from the soil. The country had rich soils and an abundance of natural resources, and people lived in a close family group in an economically self-contained society. As the country became industrialized and more people moved to town, workers found themselves dependent on a continuous income. An interruption of income, caused by misfortune or a disaster, could mean distitution and poverty.

During colonial times, people in the towns and villages recognized an obligation to assist needy individuals, and assistance was provided to those in need. However, the need for assistance became so great the communities were unable to dispense to the needy without repressing and discouraging many of those in need.

Prior to the passing of the Social Security Act of 1935, many programs and plans had been established by states and the federal government to assist those in need; however, they were found to be inadequate. The original Act was passed for the purpose of providing monthly cash benefits for retired workers and a Federal-State system of unemployment insurance.

Congress has continually expanded the Act to include additional coverage and benefits. Today, approximately 90 percent of the working population are covered by the Act.

2. Old-Age, Survivors, Disability, and Health Insurance (OASDHI)

This part of the Social Security Act is the principal method of providing income to workers and their families when they retire, become disabled, or die. It also provides protection against the high cost of health care during old age.

The OASDHI program was developed around the following basic principles:

(1) Work related - the security for the worker is based on his work; (2) No means test - an individual earns the right for benefits; (3) Contributory - the worker makes contributions to help finance the program; (4) Compulsory - coverage is compulsory; and (5) Rights are clearly defined in the law - a person's right and the amount of his benefits are clearly defined by law.

OASDAI Coverage - Nearly all work performed by citizens and non-citizens, regardless of age and sex, is covered by the Act; farmers and farm workers were covered under the Act in 1950. Most American citizens working outside of the United States are covered by OASDHI, and those that do not have this coverage are usually included in another federal program.

Benefits are paid from the contributions paid by employees, employers, self-employed, and general revenue of the Federal Government.

Employees and employers contribute equal percentages on the employees' wages. Contribution rates and limits are as follows:

1981 - 6.65 percent on earnings up to \$29,700
1982 - 1984 - 6.70 percent on all earnings
1985 - 7.05 percent on all earnings
1986 - 1989 - 7.15 percent on all earnings

A worker may receive retirement benefits as early as age 62, but benefits at this age are at a reduced rate. Disability benefits may be obtained before age 65 if the worker has a physical or mental condition that will prevent him/her from working for at least 12 months, or is expected to result in death.

Monthly retirement checks depend on such factors as age and yearly earnings. For example, a retired worker at age 65 with average earnings covered by social security of \$4,000 will receive approximately \$278 monthly.

If a worker dies, survivor checks can go to certain members of the worker's family. A lump-sum payment of \$255 is also made when a worker dies. This payment usually goes to widow or widower.

HEALTH INSURANCE FOR THE AGED (MEDICARE)

The social security program was expanded in 1965 to include Medicare, which assures hospital and medical insurance protection to people 65 years of age and older. Medicare has two parts, hospital insurance and medical insurance. The hospital insurance pays a part of the costs of inpatient hospital care and certain types of follow-up care, while the medical insurance helps pay a part of the cost of physician and outpatient hospital services. Insurance premiums for these services at the present time is \$9.60 monthly. This fee is paid by the social security recipient.

People eligible for social security of railroad retirement checks, either as a worker, dependent, or survivor, automatically have this protection at age 65.

SURVIVORS BENEFITS

Survivors insurance provides cash benefits to young children of a worker who dies and, in some cases to the widow or widower. A divorced wife, grandchildren, or parents of the deceased worker may qualify for a monthly check.

3. Social Security for Self-Employed Farmers

Self-employed farmers are those who operate a farm for profit. The farmer may be an owner-operator, partner, renter, or share farmer.

Usually, in a family farming arrangement, the head of the household is considered to be self-employed, and the earnings of the farm are credited to that person even though other members of the family contribute their efforts to the success of the farming operation. In another situation, it may be that a farmer and other members of the family actually have a partnership and all can earn social security based on the farm income.

Self-employed individuals, such as farmers, contribute at the rate about equal to $1\frac{1}{2}$ times the employee rate. The rate for self-employed will go to 9.30 percent in 1981; to 9.25 percent in 1982; to 9.90 percent in 1985; and to 10 percent in 1985.

4. Farm Employees and Crew Leaders

A farm employee is covered by the Social Security Act if the employer pays the worker \$150 or more, or if the employee works more than 20 days during the year for the employer.

Crew leaders are generally considered to be the employer if the employees receive their pay from the leader. The social security report must be completed by the employer. In some cases the farmer could be considered the employee. For example, when a written agreement between the crew leader and farmer specifies the farmer as the employer. The crew leader is the employer in the absence of an agreement and when the crew leader pays the workers, either for himself or for the farmer.

The employer must keep a record for each worker which shows the name, social security number, amount of cash wages paid, and amount of any taxes withheld from the worker's pay. The employer must also take the employee tax out of the pay of each worker covered by social security, and pay both the employee and employer portions of the social security tax to the Internal Revenue Service office.

Employers of farm workers use IRS Form 943 to report social security taxes to the IRS. This report is normally due on January 31 for wages paid in the preceding year. However, the employer has until February 10 to file the 943 if the social security taxes are deposited in full for the preceding year.

Employers must also prepare a Form W-2 (Wage and Tax Statement) for each employee who was paid wages subject to social security taxes or who voluntarily agreed to have the employer withhold Federal Income taxes.

5. Applying for a Social Security Number

Since most people pay income taxes and the social security number is used by the Internal Revenue Service to identify tax returns, nearly everyone will need a social security number. When a student enters high school, he is approaching the time when he will be employed in a job that will require him to make contributions to the Old-Age and Survivors Insurance Program. The number is used by the Social Security Administration to record payments made by a person, and one must use the number later to claim social security benefits.

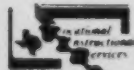
Transparency No. 1

The above transparency shows a form for applying for a social security number. On the back of an application, provided by the SSA, are the instructions for correctly filling in the application form.

For additional information about the provisions of the Social Security Act, the local social security office should be contacted. There are over 800 offices in the country.

APPLICATION FOR A SOCIAL SECURITY NUMBER

ID: CN: DO:		APPLICATION FOR A SOCIAL SECURITY NUMBER		DO NOT WRITE IN THE ABOVE SPACE	
See Instructions on Back.		Print in Black or Dark Ink or Use Typewriter			
1	Print FULL NAME YOU WILL USE IN WORK OR BUSINESS	(First Name)	(Middle Name or Initial—if none, draw line—)	(Last Name)	
2	Print FULL NAME GIVEN YOU AT BIRTH				
3	PLACE OF BIRTH	(City)	(County if known)	(State)	
4	MOTHER'S FULL NAME AT HER BIRTH (Her maiden name)				
5	FATHER'S FULL NAME (Regardless of whether living or dead)				
6	YOUR DATE OF BIRTH				(Month) (Day) (Year)
7	YOUR PRESENT AGE				(Age on last birthday)
8	YOUR SEX				FEMALE ☐ MALE ☐
9	YOUR COLOR OR RACE				WHITE ☐ NEGRO ☐ OTHER ☐
10	HAVE YOU EVER BEFORE APPLIED FOR OR HAD A UNITED STATES SOCIAL SECURITY RAILROAD, OR TAX ACCOUNT NUMBER				NO ☐ DON'T KNOW ☐ YES ☐
11	YOUR MAILING ADDRESS (Number and street, Apt. No., P.O. Box, or Rural Route)				(City) (State) (Zip Code)
12	TODAY'S DATE				
13	TELEPHONE NUMBER				
14	NOTICE: Whoever, with intent to falsify his or someone else's true identity, willfully furnishes or causes to be furnished false information in applying for a social security number, is subject to a fine of not more than \$1,000 or imprisonment for up to 1 year, or both. Sign YOUR NAME HERE (Do Not Print)				
DHEW, Social Security Administration Form SS-5 (1-76)					



AGRICULTURAL MANAGEMENT

Unit F: Agricultural Insurance

Topic 1: Life and Hospitalization Insurance

Terms: All terms underlined are included in the "Glossary of Terms."

1. Introduction to Life Insurance

Life insurance is unique in that it treats each person's eventual death as a "risk", the same way that another phase of insurance treats the possibility of crop damage as a "risk". Even though death is a certainty, we do not know when it will occur. Life insurance works the same as other phases of insurance because the cost of one person's untimely death and the resultant expenses incurred are distributed to a large number of persons.

There are two basic reasons for owning life insurance: (1) provides protection against loss of income due to the premature death of the breadwinner and (2) allows for systematic savings and investment.

The first concern of life insurance should be family protection in case of the untimely death of the head of the household. Certain expenses usually occur in connection with any death which must be paid. These might include medical bills, burial expenses, and settlement of debts as well as expenses of settling an estate or finding a new place to live.

Savings and investments can provide money for retirement in later years, or for college education for children. This may be summarized by saying that savings and investments may be converted from potential death benefits by providing a retirement fund.

Transparency No. 1

Types of Insurance Policies

Term Life Insurance - This is the purest form of life insurance. Ordinarily, the policy expires after a ten or twenty-year period. If death does not occur during this period, the policy is worthless. This is similar to a fire insurance policy in that if the house does not burn during the period the policy is in effect, no return can be expected from the policy. Term insurance is ideal to use with farm credit. If a farmer buys a farm with a \$120,000 mortgage, he can take out \$120,000 worth of term insurance to cover the mortgage in case of his death. Also, more protection is available per dollar of cost than any other type of insurance. A term

policy may change it to a permanent policy without having to take a physical examination.

Straight Life or Whole Life Insurance - This type of insurance is continuous throughout the insured person's life, with the premium being paid annually, semi-annually, or quarterly. The insured is certain that his beneficiary will collect the entire value of the policy upon his death because the policy can be terminated only by death or the failure to pay the premium. Straight life is the most commonly purchased life insurance policy. Premiums are higher initially than for term insurance, but as the policy holder grows older, they become less than for term insurance. This is the least expensive of the permanent-type insurances. This type of policy builds up a cash value; therefore, it contains investment potential.

Limited Payment Life Insurance - This insurance is similar to straight life insurance. The insured pays fixed premiums for a specified period of time only, such as 10, 20 or 30 years, or up to retirement. The premiums are higher in limited-payment insurance because they cover a shorter period of time, but the advantage to this is that they are paid during the peak earning years, and after retirement at age 60 or 65, the insurance protection continues but without the premium costs. Also, the investment portion of this insurance contract is larger than for the straight-life policy.

Endowment Insurance - This is a method of forced savings which provides for paying a fixed premium for a specified number of years, after which the insured or his beneficiary is entitled to the face value of the policy, and the policy protection expires. The costs of this type of policy are the highest of the four discussed because it has the highest level of investment, but the least amount of protection provided.

Although there are a few other little-used types of policies which do not merit mention here, it is important for the person buying insurance to realize that there are combination policies designed to meet his needs and wishes. Under this plan, the basic types of policies can be combined to produce certain advantages, which are usually paid for through higher premiums. One such policy as this is the "family income" policy, which combines term and straight life insurance. This policy insures that the beneficiary will receive a monthly income for a definite period of time after the death of the insured. For example, a 20-year policy is taken out when the insured's son is 2 years old, then the son is assured of an income until the age of 22.

2. Facts About the Life Insurance Contract

Transparency No. 2

893

Basic Protection - Be sure that basic needs for family protection are met by

straight or term insurance before taking out endowment or limited-payment life insurance. In other words, all possible expenses such as dependents living costs, sickness, or funeral expenses should be covered first, keeping in mind other sources of income such as savings and social security payments.

Available Group Insurance - Usually, group insurance is available through most farmers' associations, and it is good, low cost insurance. It should be considered supplemental to your regular insurance instead of a replacement, however.

Updating Insurance - Your insurance coverage should be reviewed from time to time in order to be sure your changing requirements are met. You may wish to change your method of settlement, change beneficiaries or to insure a child born after your present policy went into effect.

Lapsed Policies - Usually, an insurance policy will expire within one month of a missed premium payment. This is the "grace period". You may include an "automatic loan" provision in the policy, under which the company pays the premium and charges it against your policy as a loan.

Non-forfeiture Values - These are available for all policies except term insurance but only after premiums have been paid, without penalty, for specified periods ranging from one to three years. After this period, the insured has four options from which to choose:

- (1) The insured may take the cash surrender value.
- (2) The insured may purchase extended term insurance for the full face value of the policy.
- (3) The insured may purchase paid-up insurance for any amount less than the face value of the original policy.
- (4) Some companies offer an automatic premium loan as an option, or the insured may choose to have the option of renewing his old policy by passing a medical exam and paying overdue premiums plus interest in a specified period of time from the expiration date.

Also, after the non-forfeiture clause has gone into effect, you may obtain a cash loan on your policy, often at favorable interest rates.

Cash value - This is the amount of money a policy holder will receive at any time he surrenders the policy. This is similar to a savings account in that the longer the policy is in effect, the more money is put into it and the larger the interest payments made. The insured can present policy to insurance company and the company will give the insured the cash value of the policy. Also, money can be borrowed against policy.

Double Indemnity - This provision promises double payment if death occurs due to accident. As accidental death makes up only 7 percent of the total number of deaths, this extra expense is not usually desirable.

Disability Waiver of Premiums - A policy with this provision states that if the insured becomes totally disabled the policy protection continues, but the premium payments are waived for the period of disablement.

3. Introduction to Health Insurance

Health insurance programs help protect the public against the unforeseen financial burdens of serious illness or injury. Large amounts of money are spent poorly each year on health insurance due to a lack of understanding and knowledge of the various programs available.

Functions of Health Insurance

1. Protect the insured against financial hardships due to illness or injury.
2. Cover the cost of medical care in order to assure competent treatment.
3. Protect creditors by insuring the policy holder's ability to repay debt.

Health insurance is commonly divided into two coverage areas; the more frequent minor expenses and the less frequent major expenses. The prospective insurance buyer needs to decide first which of the two areas, or both, that he wishes to insure against. A family with the income capacity to handle the smaller expenses might be better off to include them in the budget and insure against the larger, more financially crippling losses. On the other hand, families unsuccessful in budgeting may find more advantage in carrying the hospital and surgical insurance. Some type of health insurance is desirable for most families.

4. Type of Health Insurance Available

1. Hospital Expense Insurance - Complete or partial payment for hospital room and board is covered by this insurance. Individual policies may cover anesthesia, medication, operating room and X-rays. This is the most widely used health insurance.
2. Surgical Expense Insurance - Payment is provided for all or part of the surgical fees. Usually, the policy lists the various operations and the payment made by the policy for each, with the more severe operations commanding the higher payments.
3. Regular Medical Expense Insurance - This type of policy covers doctor's calls, either at the office or at home. Limits are placed on the number of visits per injury or sickness and also on the number of calls per contract year. This type of policy is not often sold because it can be easily abused.
4. Major Medical Expense - This insurance policy is designed to take up where hospital and medical insurance leaves off. It is designed to handle large

medical expenses up to, and even \$15,000. Minor expenses cannot be charged to this policy by virtue of a deductible clause which states that expenses falling below a specified amount will not be covered by the policy. This amount is usually in a range of \$25 to \$500, with the \$500 deductible being the most economical.

Loss of Income Insurance - This pays up to 75 percent of earnings lost to illness or sickness for a specified period of time. Most companies will not pay more in order to discourage imagined illnesses.

Comprehensive Major Medical Insurance - Usually a custom-made policy is designed to include some of the advantages of both basic and major medical coverage and contains the deductible clause and a maximum coverage amount for the calendar year.

References:

1. Norton, Robert E., Insurance in Agriculture, Department of Rural Education, New York College of Agriculture, Cornell University, Ithaca, New York, 1966.
2. Insurance Facts for Farmers, USDA Bulletin #2137, Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402, 1967.
3. Aaron G. Nelson, William G. Murray, Agricultural Finance, 5th Edition, Iowa, State University Press, Ames, Iowa, 1967.

TYPES OF LIFE INSURANCE POLICIES

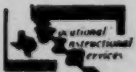
Term Life Insurance

**Straight Life or
Whole Life Insurance**

Limited Payment Life Insurance

Endowment Insurance

Combination Policies



FACTS PERTAINING TO LIFE INSURANCE

1. Basic Protection
2. Group Insurance
3. Up-dating Insurance
4. Lapsed Policies
5. Non-forfeiture Values
6. Cash Value
7. Double Indemnity
8. Disability Waiver



AGRICULTURAL MANAGEMENT

Unit F: Agricultural Insurance

Topic 2: Building, Fire, and Windstorm Damages

Note: All term underlined are included in the "Glossary of Terms."

1. Building, Fire and Windstorm Damage

Livestock, buildings, machinery, produce and supplies are all subject to damage or destruction by the elements. Fire, hail, and high winds cause extensive damage to farm property each year. A farmer must own property as a necessary part of his farm operation, and destruction of it could put him out of business. Risks of loss are an integral part of owning property, but these risks may be reduced through the use of property insurance.

There are three criteria to be considered in determining whether or not to insure property against loss:

- (1) What is the risk involved of incurring a loss?
About 2 percent of the farms in the United States suffer a fire loss each year. Individual farms, however, vary in regard to the likelihood of sustaining fire loss. Obviously, a barn with masonry walls and metal roof stands less chance of burning than one made entirely of wood.
- (2) What will be the financial burden if a loss occurs?
The farmer himself must decide the financial value of each structure he wishes to insure. Certainly, a barn used for storing foodstuffs would not need to be insured as highly as a milking parlor, cattle barn, or equipment storage barn.
- (3) What is the cost of insuring against such a loss?
This question would properly be answered by an insurance agent. Amounts vary according to the type of property, location, type of insurance company, and amount of insurance already carried. Rate discounts may be offered for the proper installation of lightning rods, metal construction, concrete walls, and fire resistant roofs.

Losses brought about as a result of fire, wind, hail or other peril are usually greater than the actual value of the property involved. Actually, most insurance companies are reluctant to cover 100 percent of the property value, because this removes incentives to avoid the loss. The farmer would be wise to adequately insure his property, keeping in mind that the purpose of insurance is not to make money for the insured, but to be used as a tool for protection against burdensome loss.

Farmers and businessmen should not expect to collect the full amount of the policy simply because the loss exceeds that amount. Methods used to arrive at losses suffered often vary widely between companies, and the purchaser should ask his individual insurance agent how his company determines the amount of losses.

A farmer who buys property insurance must have insurable interest in the property he wishes to cover. Without insurable interest, there can be no financial loss realized if the property is destroyed, and therefore, nothing to insure. Generally speaking, persons with an insurable interest in farm property are: (1) full owners, (2) partial owners and (3) persons with equitable rights in the property.

2. Forms Used in Property Insurance Policies

Property is usually insured through a standard fire insurance policy to which are added forms, endorsements or riders for the purpose of expanding the usefulness of the policy. These riders alter the standard policy to fit the individual farmer's property insurance needs.

Transparency No. 1

Some of the more common riders are:

- (1) Extended coverage insures property loss due to hail, windstorm, riot, riot attending a strike, civil commotion, vehicles, aircraft explosions, and smoke.
- (2) Windstorm provides protection against damage from windstorms and hail only and is nearly as expensive as extended coverage.
- (3) Special livestock coverage protects the farmer against loss of cattle, swine and sheep. This rider most often includes fire, extended coverage, and theft.
- (4) Produce coverage insures against loss of hay, grain, and other produce which is stored on the farm.
- (5) Blanket movable machinery covers all movable machinery except tractors, balers, combines and corn pickers. These implements must be specified in the rider if they are to be covered.
- (6) Poultry blanket coverage protects against loss of poultry due to fire, windstorm, or other damage caused by the elements.

3. Other Policy Clauses

Both the farmer and the insurance company are legally bound by every clause in the insurance contract. Generally, any statements or agreements made by the insurance agent are not binding unless they are found in the policy.

Transparency No. 2

Some of the most important clauses are:

- (1) **Assignment Clauses** - Most insurance companies enter a provision into their policies which forbids the assignment of a policy without the written consent of the company. An assignment is the transfer of the rights under the policy to a third person.
- (2) **Other Insurance Clause** - This clause voids insurance coverage on property which is already covered by a prior policy. However, permission to carry other insurance may be obtained from the company.
- (3) **Apportionment Clause** - This clause states that if two or more policies cover the property, one company shall not be liable for a greater proportion of any loss than the relationship its policy bears to the total amount of insurance held on the property.
- (4) **Work and Materials Clause** - This clause counteracts provisions which might suspend coverage if hazardous materials are kept on the premises. Risks common to a workshop, such as acetylene, increase the fire hazard, but under this clause, coverage must continue.
- (5) **Liberalization Clause** - This clause automatically extends to older policies any benefits which have been added to newer policies at no extra charge.
- (6) **Minimum Loss Clause** - Premium costs are lessened by the insured person's promise to pay the smaller damage costs himself. In other words, a \$50 minimum loss clause means that the insurance companies pay nothing on claims of less than \$50, but pay the entire claim if it is over \$50.
- (7) **Deductible Clause** - This is similar to a minimum loss clause. A specified deductible amount, usually one percent of policy, is deducted from all claims, regardless of the amount. The higher the amount of the deductible clause, the lower the premium payments.

Most policies set forth a number of conditions which may prevent full payment, temporarily suspend, or even void the policy.

Some of the more common conditions which might affect the policy are:

- (1) Property left vacant over a specified period of time (60 days, usually),
- (2) The risk has been increased by some hazardous condition not present when the policy was taken out.
- (3) Taking out additional fire insurance from another company without notifying the first company.
- (4) Title to the property has been changed, or a mortgage has been placed on it without notifying the insurance company.

References:

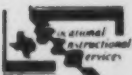
1. Norton, Robert E., Insurance in Agriculture, Department of Rural Education, New York College of Agriculture, Cornell University, Ithaca, New York, 1966.

RIDERS USED IN PROPERTY INSURANCE POLICIES

1. Extended Coverage
2. Windstorm Coverage
3. Special Livestock Coverage
4. Produce Coverage
5. Blanket Movable Machinery Coverage
6. Poultry Blanket Coverage

OTHER POLICY CLAUSES

1. Assignment Clause
2. Other Insurance Clause
3. Apportionment Clause
4. Work and Materials Clause
5. Liberalization Clause
6. Minimum Loss Clause
7. Deductible Clause



AGRICULTURAL MANAGEMENT

Unit F: Agricultural Insurance

Topic 3: Crop, Livestock, and Vehicle

Note: All terms underlined are included in the "Glossary of Terms."

Suggestions and Activities: A source unit on crop insurance has been developed by the Federal Crop Insurance Corporation for teachers and others. It may be obtained by writing to the Corporation, U.S. Department of Agriculture, College Station, Texas 77840.

1. Federal Crop Insurance Corporation (FCIC)

The loss of one year's crop means the loss of an investment which may wipe out the next 4-5 years of expected profits. Each year such losses do happen somewhere, and may happen anywhere. In order to protect themselves from such a staggering loss more farmers than ever before are carrying crop insurance. Crop insurance is to be considered a farm management tool which may pay off indirectly even in the good years due to decreased yearly premiums if no claims are filed.

As a result of demands for crop coverage, and the inability of private companies to cover crop damage, Congress in 1938 established the Federal Crop Insurance Corporation (FCIC). It was soon found that a satisfactory insurance program could be developed, and in fact, in the period 1948-65 premiums exceeded payments. In the mid 1950's the FCIC introduced its all-risk insurance. This means that the FCIC insurance now covers all unavoidable loss, regardless of cause. Not only does this crop insurance cover the quantity of harvest, but it also makes payment for decreased quality of crops due to natural disaster such as drought, excessive moisture, flood, freezing, wind, hail, insects, or disease.

Under the FCIC All-risk plan, a guarantee is given for a specific yield and quality of crop per acre. The specific amount will vary among areas, depending on normal yields, crop cost and the risks involved. For each bushel of the insured crop that does not reach the guaranteed level, a price is paid which was selected at the initiation of the policy. Thus, a farmer is guaranteed at least a return equal to his expenses.

Some counties and crops have not been eligible for crop insurance, but the Federal Crop Insurance Act of 1980 provided for expansion to all major commodities in all counties by 1985. Crops covered by insurance at the present time are wheat, grain sorghum, soybeans, cotton, corn, peanuts, rice, sugarcane, and Texas citrus.

Even if one is lucky enough not to sustain any loss, a protected crop can often be a more profitable crop. Here are six methods by which crop insurance can be utilized as a farm management tool:

Transparency No. 1

1. Maximum use of capital-insurance eliminates the need to withhold funds which might be set aside in case of a crop failure. Even though this money may be drawing interest, it can be more effectively utilized as an investment in the farm business. Also, as the investment requirements increase annually, so does the reserve requirement. Finally, a reserve amounting to one year's protection does not cover against two or more yearly crop losses as insurance does.
2. Specialization - As the expense of operation rises annually through higher machinery and equipment demands, more and more specialization of crops is required. The risk of losing one crop is greater than that of losing several diversified crops, and a bad year can totally wipe out the year's expected income. Insurance protects against this kind of loss.
3. Collateral - Any lender wants a guarantee that a loan will be repaid. Insurance provides this guarantee as well as the associated collateral with which the farmer may be able to obtain credit at better terms or at lower rates.
4. Long-term financing - Annual fixed expenses may be increased sharply through the necessity of a long-term loan made necessary for the purchase of land, machinery, and buildings required to increase profits. These commitments may stretch 10, 15 or more years. Insurance can guarantee the necessary capital to enable the farmer to undertake a long term program of farm modernization and enlargement.
5. Livestock Feeding - Many farmers produce their own livestock feed. Loss of a crop may force them to pay twice for one year's feed, for the crop they lost and for the replacement stock feed. Insurance indemnities can sharply reduce this net replacement feed cost.
6. Family finances - Savings set aside for retirement, college educations, or vacations often have to be used to replace funds lost in a major uninsured crop loss. Indirectly, crop insurance may protect money set aside for personal use, and may affect the family's standard of living.

Transparency No. 2

Crop insurance should not be considered a substitute for good farm management practices, but rather as a tool to protect against eventual catastrophe. For example, crop losses due to poor fertilizer or pesticide utilization will not be covered by insurance. Crop insurance should be kept as long as there is a risk

present. Buying crop insurance on trial for a year is like buying life insurance for a year to see if you die. Under the present FCIC policy, farmers who keep their policies effective, and who display a low record of loss may have their premiums reduced.

Each crop has special insurance features. The following is an example of how the insurance works with wheat, grain sorghum, and soybeans:

1. With these crops FCIC guarantees a specific amount of good quality production and pays an indemnity (loss payment) when production falls below the guarantee.
2. Guaranteed yields are set at 50, 60 or 65, and 75 percent of the yield averages for the county. The farmer selects one of these levels, as well as a price election per bushel, which is the price that will be paid for each bushel that the damaged or destroyed crops is below the guarantee.
3. Assume a farmer planted 100 acres of soybeans and that the selected insurance guarantee is 19.0 bushels per acre or a total of 1900 bushels, and a price election of \$6.00 per bushel.
4. Assume the farmer harvested soybeans from the 100 acres and the total yields were 600 bushels. This is 1300 bushels less than the guarantee. So the loss would be 1300 bushels.
5. The indemnity is computed as follows:

1900 bu. -	Production guarantee
- 600 bu. -	Production harvested
1300 bu. -	Amount below guarantee
	(1900 bu. minus 600 bu.)
x \$6.00 -	Price election - amount
	farmer selected to be paid
	for each bushel short of the
	guarantee
\$7,800.00 -	Amount farmer will be paid
	for losses (1300 bu. multiplied
	by \$6.00 price election)

Price selections and bushel guarantees differ with each crop and area. If the crop is not harvested, the producer does not incur harvesting costs and the guarantee is reduced as follows: The lesser of three bushels or 20 percent for wheat and soybeans; the lesser of five bushels or 20 percent for grain sorghum.

Premium rates for FCI are determined as follows:

1. Cost depends largely on the farmer. The settlement price and level of coverage selected by the farmer are used to determine the premium, as well as loss.
2. A government subsidy is applied to the premium rate. A discount of 30 percent is applied to the premium on the 50 percent and 65 percent level of coverage. The discount on the 75 percent coverage level will not exceed 30 percent of the 65 percent level of premium. The subsidy will not be applied to any crop which is eligible for ASCS disaster relief if the producer elects to participate in that program.
3. County premiums are based on estimated losses per acre over representative period of years.
4. County is divided into rate areas which are shown on actuarial map or listing. The following factors are considered in compiling the actuarial listings:
 - a. Crop insurance experience of previous years.
 - b. Consideration is given to risks of production.
 - c. Some land may be classed as uninsurable due to high risk.
 - d. All land in any given area has the same coverage and rates.
 - e. Final approved coverages and rates are set up on county actuarial tables.
5. Premium rates vary from area to area so that the premium the farmer pays will be no greater than the risk of crop loss in the area.
6. Farmer can change premium cost by adjusting the amount of protection.
7. Premium cost is based on past years experience and adjusted accordingly from the base rate. Each year a computerized printout shows a policy holder's accumulated experience. When the printout shows a low loss ratio, the premium is adjusted downward on the basis of the loss ratio and number of years with crop insurance. For high loss ratio, the number of loss years are considered and the premium is adjusted upward.
8. Premium charges are adequate only to meet losses and establish a reasonable reserve against unforeseen losses. Ninety-six cents out of every dollar earned in premiums has been returned to the farmer through indemnities.
9. Congress provides appropriations for payment of FCIC operating expenses. Therefore, premium rates do not include a charge to cover operating costs of the Corporation.

Any person who has a share in an insurable crop may obtain FCIC. Landlords and tenants can insure their interest in a crop separately, or an application may be filled jointly by two or more persons, such as tenant and landlord, or co-owners to cover their joint interest.

Closing dates are established each year for making application for insurance. After these dates applications are not accepted. Closing dates are necessary in order to get the insurance in force before crop prospects can be determined. Otherwise, farmers would take insurance only in the years that crop prospects are poor. If conditions develop that create an unusual risk to the Corporation, closing dates may be early.

Farmers carrying insurance have to file an acreage report within 30 days after completion of planting. Location of crop, number of acres, and share in crop is reported. A form for making this report is mailed to the farmer at planting time.

In event of a loss, the farmer promptly reports the loss to the local FCIC office so that loss adjustment can be performed while the needed evidence and information supporting the claim are available and can be verified. An FCIC adjuster visits the farm to determine extent of crop loss. If an insured no longer intends to care for a damaged crop and wants to put the insured land to another use, he/she must first obtain written consent from the FCIC adjuster. Consent to put to another use will be given when it is too late to replant to the same crop.

There is a substitute crop provision in some cases where acreage planted to one crop is released and planted to another. The wheat, barley, corn, flax, oat, rye, soybean, sugarcane, sunflower, and sweet corn policies provide that the greater of the appraised production or 50 percent of the applicable guarantee be used as production to count when acreage is released under the following circumstances:

1. Harvest of the original crop is not yet general in the area;
2. The substitute crop seeded on the acreage on which consent was given must meet all the requirements of insurability, such as timely seeded, insurable practices, etc.; and
3. The substitute crop is for harvest in the same calendar year.

If the conditions are met and the insured has insurance on the substitute crop, the substituted crop will be fully insured.

2. Livestock Insurance

The ownership of livestock constitutes a risk in the same manner as ownership of crops or any other valuable which may be lost. Unless the owner is in a position to absorb the financial loss himself, the livestock should be insured. In order to obtain insurance, the owner usually is required to supply the following information about the animal.

Transparency No. 3

1. Name
2. Registration number
3. Tattoo or ear tag number
4. Date of birth
5. Amount of coverage and period of insurance required
6. Certification of good physical health based on a veterinarian's examination made within five days prior to application

In general, insurance companies cover death loss due to accidental causes as well as disease where the owner is found to not be at fault. The following exclusions are common to most livestock insurance policies:

1. Death due to operation or inoculation not conducted by a qualified veterinarian.
2. Poisoning, unless the poisoning was accidental. In the case of accidental poisoning, not more than 65% of the total policy value will be paid.
3. Intended or purposeful injury.
4. Death due to any war or open hostility.
5. Death due to careless handling by the owner or any of his employees.
6. Any misrepresentation by the owner concerning the insured animal.

It is most important that the entire policy be read before applying for insurance, and that it is totally understood. The insurance agent should be contacted for an explanation if the farmer does not understand any portion of it. The agent is trained in the coverage of his policies, and is the logical person to tell you what coverage is best in your situation. The following facts should be kept in mind when insurance protection is needed:

1. The standard Livestock Mortality Policy covers death only,
2. The policy protection is not intended for eventual gain or profit, but is for protection of investment only.
3. Insurance cannot be expected to cover normal maintenance expenses such as veterinary costs or similar expenses.
4. Mortality coverage does not insure against loss of the animal's ability to do the job for which it was kept.
5. Required slaughter by governmental order is not covered.
6. When no actual sales transaction has occurred, a fair and conservative price for the animal will be set by competent and impartial judges.
7. Livestock Mortality Insurance is identical to term life insurance for humans, and is payable accordingly. Reinsurability of the animal must be proven before the policy can be renewed.
8. Cancellation may be brought about only by the insured or by the company according to regulations set in the policy.
9. Policies may not be transferred from one person to another, or from one animal to another without company approval.

Livestock coverage is a very important instrument by which a farmer can protect his investment. However, he must understand his policy so that he will not unknowingly void his protection.

Herd Insurance

No less than ten head may be insured under Group Insurance Plans. No one animal may be worth more than half the total herd value. The annual premiums usually amount to about 3% of the total herd value, and no indemnities may be paid until total loss is in excess of the premium. In other words, total cost of insuring a ten head, \$10,000 herd is \$300. If each animal is worth \$1,000 each, loss of one head returns only \$700 in indemnities. Each successive loss returns the full \$1,000 per head indemnity. Horse group insurance differs in that no indemnities are paid until the loss exceeds 2% of the total value of the herd. Otherwise, the policies are very similar. Animals may be substituted at no charge if they are of equal value. Animals deleted from the policy should be replaced immediately to avoid reducing the total insurance volume.

Transparency No. 4

Specialized Livestock Coverage

1. **Special Herd Insurance for Cattle** - This specialized insurance requires a minimum of six head at the rate of about 5% of the total value. No one animal may exceed the value of the other five. The indemnities pay the full value of the loss; no deduction is involved.
2. **Four-H and FFA Calf Club Accrual Plan** - There are two separate methods of insurance offered under this plan:
 - (A) **Six-month accrual plan** - Each calf is insured at about 5% of original cost. This is the total premium paid. There is an automatic accrual value increase of 10% of original cost each month the policy is in force, not to exceed five increases.
 - (B) **Twelve month accrual plan** - This plan is very similar to the six-month plan. The original cost of each calf is insured at 9% of original cost. The accrual value increases at the rate of 10% each month.

By this method, the amount paid for accrued value coverage is lower than the normal annual premium of 6%. By the end of a year, the insured value of the animal is more than twice the original cost.

These policies also cover animals during transportation and exhibitions. Another advantage is the lower cost per year of protection as well as coverage against loss from theft.

3. Cargo Insurance

This plan covers animals being transported from one point to another and includes loss due to fire, overturn, collision, collapse of bridges and loss due to natural causes. It does not cover losses due to negligence, delay or loss of market, injury due to shifting of load, truck or equipment failures or damage caused by strikes or other forms of hostility.

4. Poultry Coverage Policy

This policy plan protects chickens and turkeys against losses due to fire, lightning, windstorms, rainstorms, and other acts of nature. Birds kept in houses are given preferable rates over birds kept on range. There is usually a different policy used for starter chicks than for laying hens due to advantageous premium rate. The policy value for chickens increases in the following manner:

- 1¢ per day per chick for the first fifty-five days
- 1 3/4¢ per day per bird for the next twenty-five days
- 2 1/4¢ per day per bird for the next thirty days
- 4 1/2¢ per day thereafter until maximum coverage

5. Personal Liability Coverage for Livestock

Under this plan, for a nominal fee, the farmer can protect himself against livestock being killed on the highways through faulty fences and wandering cattle. This policy covers the cost of the dead animal up to \$300 market value plus damage to the vehicle which hits it if the owner of the cow is found negligent. If the fences are tight and gates were kept closed and the owner is not otherwise at fault, the policy may not cover the damage to the car.

In general, the information given above is correct; however, rates and coverages change frequently so these may not be correct.

3. Vehicle Insurance

Increased usage of motor vehicles, both cars and trucks, has vastly increased farmers' risks and financial obligations. Economic losses also increase each year due to motor vehicle accidents. Due to ever-increasing court settlements, farmers should protect themselves from financial hardships which might arise from the operation of their vehicles.

Shopping for auto insurance can present many problems and leave one very distraught. However, if the basic features are known, one can shop with more confidence and is likely to get more for the money. Auto insurance can be bought in the form of a bundle of coverage or each section in the bundle can be bought separately.

Transparency No. 5

Types of Vehicle Insurance

1. **Liability** - is the core of an auto policy. With liability coverage the insurance pays for bodily injury and property damage to others when the insured is legally responsible for the accident. Claims against the insured may be settled out of court; or if court action is brought against the insured, the company will defend the insured. The protection covers the insured, resident members of the family and others who drive with insured's approval. The insured and members of the insured's family are also covered when driving another car with the owner's consent.

Liability coverage is stated separately for bodily injury and property damage. The maximum coverage is generally stated in a form such as 10/20/5. This indicates the company is liable for up to \$10,000 for any one person injured; up to \$20,000 for all injuries in the same accident; and up to \$5,000 for damage to the other car, fences, and other property. For damages exceeding these amounts the insured is responsible.

Liability coverage pays for other people's injuries - not the insured's.

2. **Medical Payment Insurance** - This is the coverage that pays for the insured and insured passenger's medical fee regardless of who was to blame for the accident. Coverage is sold in amounts ranging from \$500 to \$5,000. The limit is for each person injured, so with a \$500 plan, four people would collect a total of \$2,000.
3. **Uninsured Motorist Protection** - offers protection to the insured, insured's spouse, and resident children if struck while driving or walking by an uninsured or hit-and-run-driver. The coverage applies only when the other driver was to blame for the accident. Bodily injury payments generally are limited to minimums of state liability regardless of the face value of the basic policy.
4. **Collision Insurance** - pays for damage to insured's car when he/she hits another vehicle or an object such as a tree, telephone pole, etc. Collision coverage is usually sold in the form of \$50, \$100, \$200, or \$250 deductible. If the insured collides with a tree and there is \$150 damage to the car and the policy is \$100 deductible, the company will pay \$50. The larger the amount of deductible, the less the premium. In most instances by buying a \$100 deductible collision rather than \$50 will cut premium cost 20 percent.

The insurance company keeps its responsibility to the "actual cash value of the vehicle." The most one could expect to receive for a \$700 car would be \$700. Regardless of how dear to the insured's heart the "old crate" is, the company will not spend \$800 to repair it. One should consider the value of his/her car. It may be unwise economically to buy collision coverage for an old car.

5. **Comprehensive Insurance** - covers losses caused by fire, wind, theft (excluding CB radio), vandalism, collision with animals, explosions, flood, and lightning. Limited coverage is generally provided by comprehensive for personal effects left in a car. Additional coverage for personal effects left in a car is also covered by a homeowner's insurance policy.
6. **Accidental Death and Dismemberment Coverage** - pays a lump sum for death in a car accident, loss of a limb, blindness, fractures, and dislocations, plus a disability benefit each week. This type of insurance often overlaps coverage from liability and other insurance. Therefore, it should be checked to see that premium money is not spent for overlapping coverages.

Premium rates for vehicle insurance may vary widely depending on any of several conditions. Some of these conditions are listed below:

Transparency No. 6

- (1) **Age of the driver** - On the 25th birthday of the insured males, most vehicle insurance rates decrease markedly.
- (2) **Principal location of vehicle** - Usually vehicles operated exclusively in cities are more susceptible to accidents than those operated principally in rural areas.
- (3) **Amount of protection desired** - Premium rates increase as the policy protection increases.
- (4) **Accident experience of vehicle owner** - Premium rates are higher for those vehicle operators with a history of accidents than for safer drivers.
- (5) **Whether the vehicle is used for business, for pleasure, or for both purposes**, farm vehicles used for business are normally subjected to more risk of damage than those used strictly for purposes of pleasure.

In deciding which insurances to carry, and in what amounts, the farmer should contact his insurance agent who can advise him as to the areas of greatest risk and how to receive the greatest benefit for his insurance dollar.

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1. Handbook for the Home, 1973 Yearbook of Agriculture, U.S. Department of Agriculture, Washington, D.C.
2. "Livestock Mortality Insurance," Texas Farm Bureau Insurance Company, Waco, Texas.
3. "4-H - FFA Club Project Insurance," Texas Farm Bureau Insurance Company, Waco, Texas.

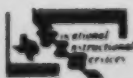
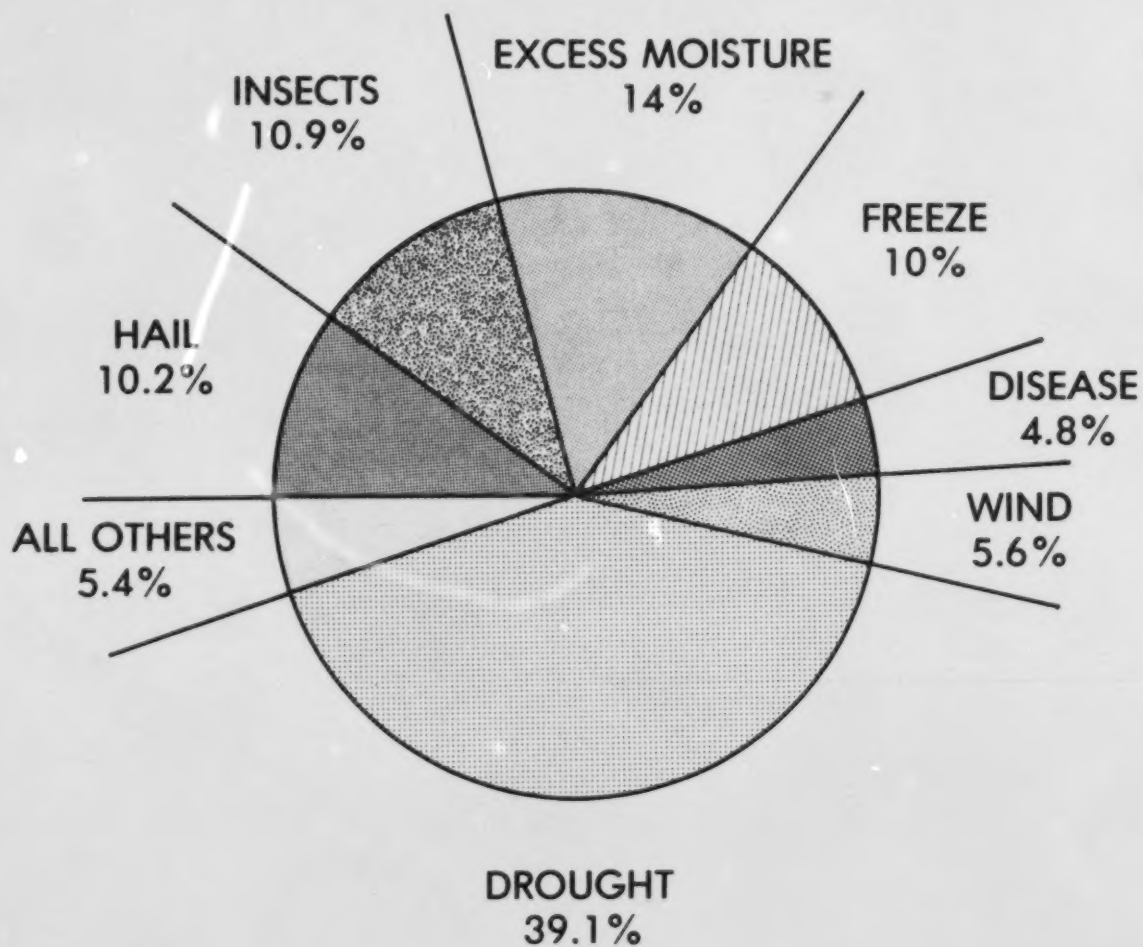
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U.S. Department of Agriculture, College Station, Texas 77840.

INSURANCE AS A FARM MANAGEMENT TOOL

- 1. Maximum Use of Capital**
- 2. Specialization**
- 3. Collateral**
- 4. Long-Term Financing**
- 5. Livestock Feeding**
- 6. Family Finances**

MAJOR CAUSES OF CROP LOSSES



REQUIRED INFORMATION FOR LIVESTOCK INSURANCE

1. Name
2. Registration Number
3. Tattoo or Ear Tag Number
4. Date of Birth
5. Amount of Coverage and
Period of Insurance Required
6. Veterinarian's Certificate
of Health

SPECIALIZED LIVESTOCK COVERAGE

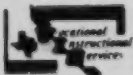
- 1. Special Herd Insurance for Cattle**
- 2. Four-H and FFA Calf Club Accrual Plan**
- 3. Cargo Insurance**
- 4. Poultry Coverage Policy**
- 5. Personal Liability Coverage for Livestock**

TYPES OF VEHICLE INSURANCE

1. Bodily Injury Liability Insurance
2. Property Damage Liability Insurance
3. Uninsured Motorist Protection
4. Medical Payments Insurance
5. Comprehensive Insurance
6. Collision Insurance

FACTORS INFLUENCING PREMIUM RATES

1. Age of the Driver
2. Principal Location of Vehicle
3. Amount of Protection Desired
4. Accident Experience of
Vehicle Owner
5. Principal Use of Vehicle



AGRICULTURAL MANAGEMENT

Unit F: Agricultural Insurance

Topic 4: Liability Insurance and Title Policies

1. Introduction

This type of insurance is separate and distinct from that designed for automobiles and trucks. It is designed to insure any risks one may encounter in operating the farm business. These risks are normally classified into two groups: (1) those suffered by farm employees and (2) those suffered by the general public.

2. Farmer's Comprehensive Personal Liability

Farmers are held responsible for the safety of anyone who may be on their property, whether consent has been given or not. This is known as Public Liability. Personal Liability insurance protects the farmer from loss as the result of a lawsuit brought by an injured person. Court awards in lawsuits of this type are often quite high, resulting in financial losses to farmers. The cost per dollar of protection is relatively low; therefore, this coverage is considered to be worthwhile. The basic coverage rates include one farmstead and up to 160 acres, with greater premiums levied for larger acreages. This policy does not cover accident or injuries for any regular employees.

Employers' Liability - This is written as a rider to the Farmer's Comprehensive Personal Liability and is designed to protect the employer against suit brought by an injured employee. The insured employee must prove that the farmer was negligent before the insurance company is required to pay the claim. In order to avoid court costs, companies will often make a settlement without requiring that proof of negligence be shown. This type of policy offers about the same protection for the employer as the Workman's Compensation but for much less cost. However, there is much less protection offered the employee.

Workman's Compensation - This policy offers greater protection to both the employee and the employer than the Employer's Liability. It covers all hospital bills, death benefits, loss of limbs, and compensates for loss of salary at the rate of two-thirds of the employee's salary up to a maximum amount. Payments are made, however, with no regard to negligence by the employer. There is no limit to the amount of protection an employer may purchase, and no maximum limit which the employee can collect under the provisions of this policy.

There are two criteria which should be considered in determining the amount of liability insurance which a farmer needs: (1) the number and type of employees and (2) the kind of work they do. Hazardous work and unskilled workers increase the risk of accident injury.

3. Title Policies

A title policy is a form of insurance that protects the purchaser of real estate from loss caused by an imperfection in the title to his property. The purchaser usually buys the insurance which is equivalent to the purchase price. However, more insurance may be purchased and should be if expensive improvements are to be made to the property.

Title policies are obtained from a licensed insurance title company, and the rate is based on the value of the property. A title policy on a piece of property valued at \$1500 costs \$49.00; a title policy on property valued at \$20,000 costs \$157.00. The owner of the property may purchase a title policy at any time; but usually the purchaser requires the seller to furnish the policy. If the seller is to pay for the policy, it should be included in the sales contract. To protect depositors and stockholders, most mortgage lenders require title insurance on property on which they have lent money.

AGRICULTURAL MANAGEMENT

Unit E: Agricultural Records

Topic 5: Texas Workmen's Compensation Insurance

Terms: All terms underlined are included in the "Glossary of Terms."

Note: The Texas Workmen's Compensation Act does not include farm or ranch laborers, but there are many agriculturally related jobs covered by the Act.

1. Introduction

Workmen's compensation is a form of insurance designated to provide medical benefits and, in some cases, financial payments for eligible employees who suffer injuries or occupational diseases arising out of and in the course of their employment. Financial payments are made to offset loss of wage-earning capacity and/or specific loss of a part of the body such as a foot, loss of hand, etc., as a direct result of job-related injury. The employee is entitled to all medical services, hospital services, and medication reasonably required at the time of injury and any time thereafter to cure and give relief from effects resulting from the injury.

The federal government provided workmen's compensation for its civilian employees in 1908. Following the lead, all states now have laws which provide some form of workmen's compensation for employees of the state and certain commercial firms. State compensation programs are independent and free of federal authority and administration.

The Texas Workmen's Compensation Act was enacted into law by the Texas Legislature in 1913. The purpose of the Act was to provide financial assistance to employees injured in connection with their jobs and to survivors of employees killed on the job. Texas Workmen's Compensation Insurance is administered by the Industrial Accident Board, P. O. Box 12757, Capitol Station, Austin, Texas 78711.

The Texas Workmen's Compensation system does not require the employer to carry the insurance, but it provides employee insurance coverage for employers with three or more employees who elect to provide the coverage and carry the insurance. Employers with fewer than three employees should carry some other type of accident insurance. Since the Texas Workmen's Compensation Act is based upon the abrogation of the common law defenses of contributory negligence, assumed risk, and fellow servant doctrine, the injured employee may bring suit for damages; and the employer cannot plead any of the above defenses. However, the employee must prove negligence.

Excluded under the Texas law are domestic servants or casual employees engaged in employment incidental to personal residences, farm laborers, ranch laborers, and operators of steam, electric, street, or inter-urban railways as a common carrier. Masters of/or seamen on vessels engaged in interstate or foreign commerce and any employee or classification of employees for whom a rule of liability or method of compensation has been or may be established by the Congress of the United States are also excluded.

2. Securing Workmen's Compensation Insurance Coverage

An employer desiring to participate in the WCI Program should contact his/her local insurance agent to obtain coverage. If the local agent does not provide this type of insurance he/she can recommend an agent who does. The premium rate for WCI coverage varies and is determined by the number of employees a firm has.

3. Protection Provided by Workmen's Compensation Insurance

Workmen's Compensation Insurance provides a weekly compensation rate for up to 401 weeks and medical expenses to employees who receive injuries while they are actually performing duties for their employer.

Although there are several types of injuries, they are all classified as either general (injury to body as a whole), or specific (injury limited to a specific member, limb, organ or part of the body); and are either total or partial; and may be permanent or temporary. An employee might have temporary total disability, temporary partial disability, permanent total disability, or permanent partial disability.

The weekly compensation rates are as follows:

Weekly - \$133.00

Temporary Total Disability - up to 401 weeks at 66 2/3 percent of average weekly wage (but not more than \$133.00 or less than \$25.00 per week).

Temporary Partial Disability - up to 300 weeks at 66 2/3 percent of the difference between earning capacity prior to and after injury - but not to exceed \$133.00 per week.

Permanent Partial Disability - (in a general injury by the loss of wage earning capacity) - is the difference between earnings prior to the injury and earning capacity after the injury for up to 300 weeks.

Loss of a limb or member of the body or loss of use of the limb or member of the body is compensated according to the following table discounted 4 percent:

Thumb	\$7,799.18	60 weeks at \$133.00
1st Finger	\$5,882.33	45 weeks at \$133.00
2nd Finger	\$3,943.70	30 weeks at \$133.00
3rd Finger	\$2,769.95	21 weeks at \$133.00
4th Finger	\$1,983.00	15 weeks at \$133.00
Loss of Hand	\$18,855.72	150 weeks at \$133.00
Loss of Arm at or above Elbow	\$24,681.58	200 weeks at \$133.00
Big Toe	\$3,943.70	30 weeks at \$133.00
Any other Toe	\$1,324.49	10 weeks at \$133.00
Loss of Foot	\$15,859.37	125 weeks at \$133.00
Loss of Leg at or above Knee	\$24,681.00	200 weeks at \$133.00
Loss of Sight (1) Eye	\$12,805.97	100 weeks at \$133.00
Loss of Hearing in both Ears	\$18,855.72	150 weeks at \$133.00
Hernia	\$3,423.02	26 weeks at \$133.00

In case of death, the surviving spouse will receive benefits for life, and children will receive benefits until age 18 or if in school to age 25. Benefits are calculated at 66 2/3 percent of the average weekly wage not to exceed \$133.00 per week.

If the surviving spouse remarries, however, he/she will receive a two-year lump sum payment of \$13,832.00. In addition to the weekly fatality benefits, the insurance carrier is required to pay up to \$1,250.00 funeral expenses.

4. Filing and Closing a Claim

When injured, (1) the employer must be notified of the injury within 30 days from the date of the injury, and (2) a claim form must be filed with the Industrial Accident Board in Austin within 6 months from the date of the injury. It is extremely important to keep these two time limits.

At the time of injury, an employee is entitled to immediate first aid treatment. All first aid expenses and future medical expenses are the responsibility of the employer/insurance carrier. These will be paid as long as the doctor or chiropractor treating the injured worker submits the necessary reports concerning the worker's condition to the Industrial Accident Board.

AGRICULTURAL MANAGEMENT

Unit G: Marketing

Topic 1: Marketing Agricultural Products

Note: All terms underlined are included in the "Glossary of Terms."

1. Introduction to Marketing

When this country was first settled there was not a marketing system or a need for one; the consumer was also the producer. If the farmer had a surplus of a product, he either traded it for one that he did not have, or he sold it in a village. As long as the people in the villages were able to produce and trade for the products that they consumed, an organized marketing system was not needed.

The agrarian society which dominated our country in its early history no longer exists; today we have an urban society. About four percent of our population (farmers) are producing food and fiber for the other ninety-six percent. The distribution of agricultural products requires a complex marketing system, and several middlemen must handle most products before they reach the consumer. An example of the channels that may be used in marketing feeder cattle is given in the following transparency.

Transparency No. 1

2. Principles of the Free Enterprise System

There are basically two forms of government in the world-popular and dictatorial. The U.S., England, France, Japan, and Canada are countries which have a popular form of government, while Russia, China, and Cuba have the dictatorial form of government.

Countries having the popular form are referred to as capitalists, and operate under certain underlying principles. These principles include the system of private enterprise, free-market economic system, competition, private ownership, rewards, and very little governmental competition.

A dictatorial form of government advocates a different set of principles, which are listed as follows: abolition of private property and inheritance; governmental ownership of all banks, credit agencies, transportation and communication systems; compulsory labor; and operation of all productive enterprises by the

government. The driving force behind any economic system is the people, and they have certain needs and wants. An economic system must provide for the production and distribution of these items.

Under the popular form of government (capitalist system), which includes the system of marketing, the people of the U.S. enjoy the highest standard of living in the world. The U.S. system of production and marketing has provided more agricultural products than the U.S. citizens can consume. Under the capitalist form of government and an efficient marketing system, the U.S. has a problem with surplus agricultural products rather than a scarcity of them.

3. Foreign Markets

At one time the domestic market was the most important to the U.S. farmer. However, today the farmer must consider both the domestic and foreign markets when planning a farming program.

Nearly one-third of all U.S. crop production was exported in 1978. This compares with about one-fourth in 1970. Wheat, rice, corn, soybeans, grain sorghum, cotton, tobacco, and certain fruits and vegetables are among the major exported crops.

The largest markets for U.S. farm products in 1977 were Japan, West Germany, Canada, Holland, and the USSR. Other important purchasers were the United Kingdom, Korea, Italy, Spain, and Taiwan.

Farm organizations, cooperatives, governmental agencies, and independent firms have conducted extensive studies in foreign countries to determine the demand for agricultural products grown in this country. as the world population continues to grow, it is expected that the foreign demand for agricultural products will increase.

4. Marketing Functions

A marketing function is considered to be any activity which occurs in the marketing process. Even though farm products travel through different channels before reaching the consumer, the marketing system provides about the same functions for all agricultural products. Usually, there are seven different functions involved in marketing a product.

Transparency No. 2

Assembling and Buying - The first function is assembling and buying the product. The product may be purchased by any of several marketing methods.

Transporting - An agricultural product is usually transported before and after it is assembled. The U.S. has a network of railroads, waterways, airways, and highways which are manned around the clock to transport farm produce, as well as other items.

Storing - Storage must be provided for all agricultural products. Many perishable products must be stored in refrigeration. This is a necessary function which is sometimes expensive.

Processing and Packaging - Nearly all farm products must be processed; and many products such as cotton, soybeans, and meat animals are of little value to the consumer until they are processed. Products are packaged to make them easier to store, ship, and sell. Prepackaging of agricultural products is becoming a practice which is used extensively, for it makes the products easier to handle and also increases sales.

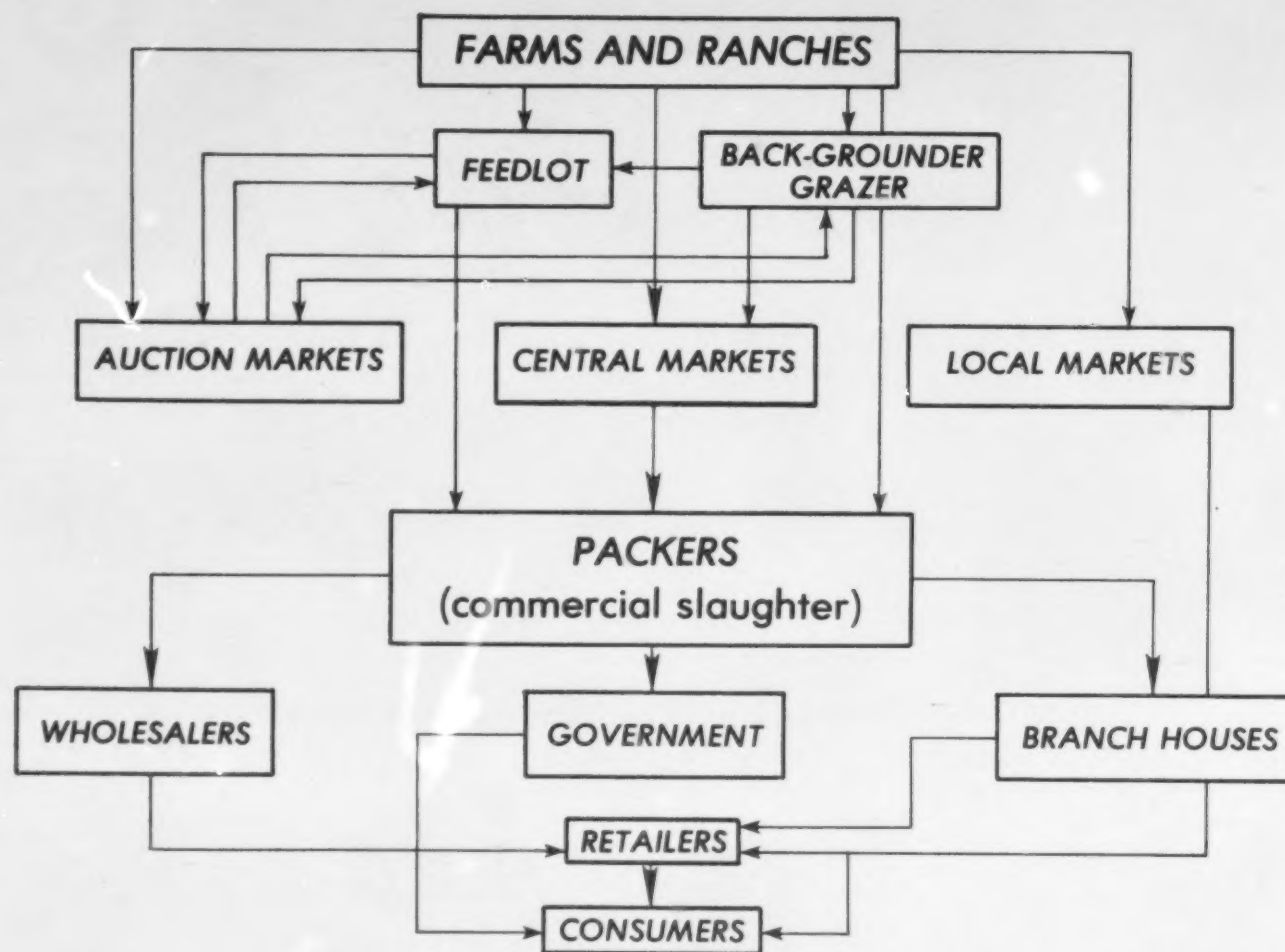
Grading and Standardizing - All agricultural products have an U. S. D. A. grade and are usually standardized by grade before being sold to the consumer.

Financing and Risk Bearing - Someone must finance and bear the risk of loss in performing each of the functions involved in marketing agricultural products. Some of the risks are deterioration, loss from accident, insect damage, and market fluctuation.

Selling - All products must be sold, and some are sold several times before they reach the consumer. A slaughter steer might be used as an example. As a calf, the steer may have been sold to an order buyer, and the order buyer sells it to a feeder. The feeder, after feeding the steer until it reaches an acceptable grade, sells it to a packer, and the packer sells the carcass to a retailer, who sells it to the consumer. In this example, which is not unusual, the steer was sold five times before it reached the consumer.

The cost of the different marketing functions is the difference in what the farmer receives and what the consumer paid for the product. Labor is the principal cost in performing the marketing functions, and this cost usually amounts to about 50 percent of the consumer's cost. Other functions, including transportation, cost about 44 percent. This leaves 6 percent for profits.

LIVESTOCK MARKETING CHANNELS



FUNCTIONS OF THE MARKETING SYSTEM

Assembling or Buying

Transporting

Storing

Processing and Packaging

Grading and Standardizing

Financing and Risk Bearing

Selling

AGRICULTURAL MANAGEMENT

Unit G: Marketing

Topic 2: Market Demands and Outlets

Note: All terms underlined are included in the "Glossary of Terms."

1. Market Demands and Seasonal Price Variations

When planning a farming operation, the farmer must try to anticipate the demand (from the standpoint of quantity and quality) for his products. The price and demand for agricultural products have gradually increased from 1800 to the present time. In order to anticipate the demand and price, the farmer should use past records, which are available from several sources.

Vocational agriculture students are aware there are three general factors which influence the price a farmer will receive from his products. These are supply, demand, and general price level. It is impossible for any single relationship and interaction of all three factors cause price change. Possibly, trends, cycles, and seasonal changes are the most important factors for the farmer to consider in estimating the demand and price of a product. These are included under the general factors already mentioned. Trends reflect changes which take place over a period of several production cycles and reflect a change in the total economy. Long-range trends are difficult to anticipate. Production cycles are very closely related to the time required to expand or decrease an enterprise. However, other factors may affect a production cycle.

Transparency No. 1

When an enterprise becomes unprofitable, farmers reduce production, produce another product, or do both. When production has been reduced to the point that demand for a product exceeds supply, the price starts to increase. When the production of a specific agricultural product becomes profitable, farmers increase production of it, and eventually, the supply exceeds the demand. Thus, the price is reduced, and the cycle starts again. Therefore, a price cycle may be defined as the period of time in which the price of an agricultural product advanced from a low point through a high point and back to a low point. Cattle cycles usually span a period of about 15 years. Because of multiple births and a shorter gestation period, swine cycles are much shorter.

Transparency No. 2

The above transparency may be helpful in determining the length (number of years)

of a pork production cycle. Pork production decreased from 1970 through 1972 and increased from 1972 through 1974, a period of four years. The next cycle on the transparency is 1974 through 1976. This would indicate that the pork production cycle is from two to four years.

Also, one should observe the price of hogs in relation to production. Prices are the highest when production is the lowest.

Transparency No. 3

Seasonal Price Variations

Prices of farm products vary according to the season of the year. Several factors cause this variation:

Production - Since most agricultural products are produced in a certain season, production is definitely a factor. Normally prices are the lowest at harvest season.

Demand - The demand for most agricultural products is greater during certain periods.

Location of Production - A product is usually cheaper in the area where it is produced; this is especially true during harvest season.

Amount of Processing - Products that require a lot of processing usually have less price variation; however, this is a contributing factor in several price variations.

Type of Product - Perishable products vary in price more than nonperishable products.

Changes in Production Methods - A change in the method of production influences the seasonal price variation. The use of greenhouses for producing vegetables and calving at a time different from the usual, are the examples of changing production methods.

Improvements in storage facilities, transportation, and production techniques have helped to eliminate some of the variation in prices, and an attempt has been made to eliminate as much seasonal price variation as possible. However, the farmer should consider the factor which influence seasonal price variations and adjust his operation to take advantage of them.

2. Factors that Affect the Marketing of Farm Products

Necessayr marketing functions are about the same for all agricultural products. In order for the farmer to be successful, he must understand the cost of marketing (difference in the price he receives and that which the consumer pays for his

product). Then he can adjust his operation to produce the quality demanded by the consumer and market his products on the most favorable market at the appropriate time. It is important that the farmer understand the many factors which influence the price and demand for a product.

Transparency No. 4

3. Marketing Agencies

There are many different agencies involved in marketing the wide variety of agricultural products produced in the U.S. These agencies provide a service to the industry and the country. As each agency's function is explained, the student should consider the fact that many agricultural products marketed are not grown in the area where he lives. In fact, production in his area represents a very small part of the total agricultural production.

Transparency No. 5

Commission Men - When reference is made to a commission man, a Texan usually thinks of a person at a central livestock market who sells livestock consigned by the producer to a market agency, often called a commission company. There are other commission men who sell agricultural products in other areas such as vegetables, tobacco, eggs, and other products. In addition to selling the product, the commission man collects from the buyer, deducts his commission and other marketing expenses from the receipts, makes an accounting of the sale to the owner, and remits the proceeds to the owner. The commission fee is a small percentage of the total receipts.

Wholesaler - A wholesaler purchases agricultural products in large quantities and sells to a jobber or a retailer. The wholesaler usually places a small "mark-up" on the product so he can make a profit.

Jobber - A jobber buys in large quantities, breaks the product down into smaller quantities, and sells to retailers. A jobber may specialize and deal in only one product.

Broker - A broker represents both sides of a transaction. He brings the buyer and seller together without handling the product. A broker may represent an individual or a firm and handles carload lots of products such as potatoes, tomatoes, eggs, and grains.

Retailer - A retailer performs the last function before a product reaches the consumer. He keeps an inventory of items which he has purchased from a wholesaler, jobber, or farmer. If the items sold by the retailer were traced through the marketing channels, one would find that most items would have been handled by the agencies mentioned above.

4. Methods of Marketing

There are many methods used by farmers to market their products. The one selected should favorably impress the prospective customer with the product and bring the farmer the best price.

Transparency No. 6

There are five methods of marketing agricultural products. An explanation of each method follows:

Local Buyer - There are several classifications for the local buyer. He may be a trader or dealer who handles a single product or several similar products. A person who purchases agricultural products from a roadside stand may also be classified as a local buyer.

Direct Buying - Many processing plants buy from the producer for direct shipment to a processing plant. Some of the buyers for these plants may live in a community which serves as an assembling and shipping point. Since many agricultural products are seasonal, many buyers follow the crop harvest.

Central Markets - Central markets are usually located in the center of a large production area, or they may be located in an area where adequate facilities for handling and transporting agricultural products are provided. Products are usually available in large quantities at a central market, and buyers are usually able to purchase the quantity they need. Central markets are important as a means of bringing together buyers who are interested in purchasing products in large quantities.

Auction Markets - There has been a tremendous increase in the number of livestock auctions since World War II. This type of market is possibly an outgrowth of an earlier method of selling, the individual auctioning his products on the village square. All kinds of agricultural products are sold through auctions.

Cooperative Marketing - To market their products cooperatively, farmers pool their products. There are several advantages of marketing by this method: a larger quantity is available to the buyer; the farmer's bargaining power is increased; transportation is usually easier to obtain; marketing is more efficient; farmers are able to perform more services, thereby eliminating some middlemen; and research has proven that cooperative marketing improves farming.

FACTORS THAT AFFECT PRODUCTION CYCLES

Length of Gestation Period

Wars

Credit and Finances

Climatic Conditions

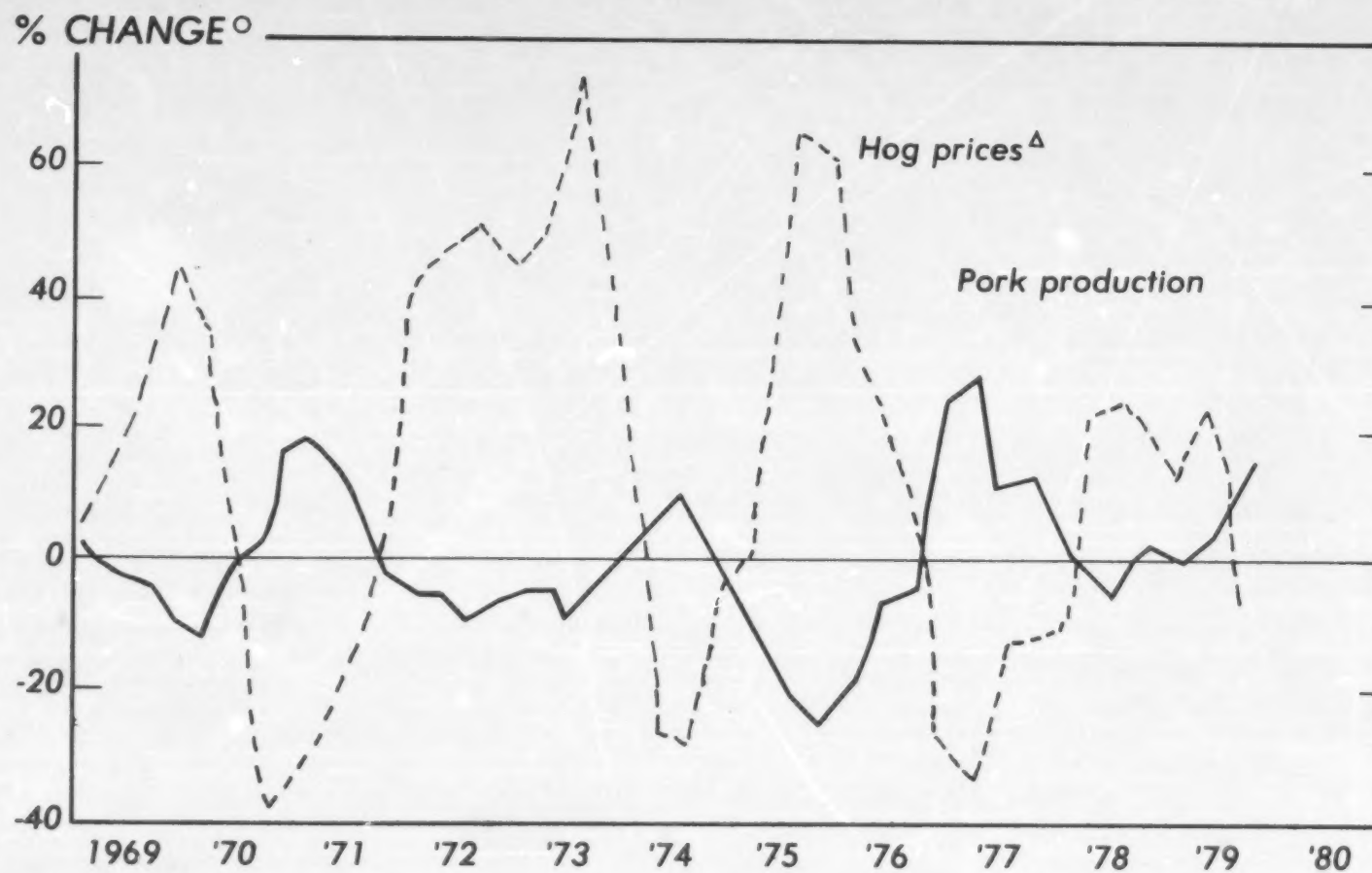
General Economic Conditions

Availability of Certain Supplies

Trends in Consumption

Competition from Other Products

CHANGES IN HOG PRICES AND PORK PRODUCTION



[○]PERCENTAGE CHANGE FROM PREVIOUS YEAR. ^ΔBARROWS AND GILTS, 7 MARKETS.

FACTORS THAT CAUSE SEASONAL PRICE VARIATIONS

Production

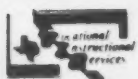
Demand

Location of Production

Amount of Processing

Type of Product

Changes in Production Methods



FACTORS THAT AFFECT THE PRICE AND DEMAND OF FARM PRODUCTS

Supply and Demand

Production Cost

Climatic Conditions

Substitutes

Transportation Available

Market Conditions

World Conditions

Season of the Year

Wars

Advertising

Concentration of Population

MARKET AGENCIES

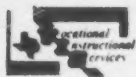
Commission Men

Wholesalers

Jobbers

Brokers

Retailers



METHODS OF MARKETING

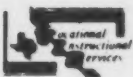
Local Buyers

Direct Buying

Central Markets

Auction Markets

Cooperative Marketing



AGRICULTURAL MANAGEMENT

Unit G: Marketing

Topic 3: Government Marketing Programs

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities: The vocational agriculture teacher may wish to invite the County ASCS executive director to explain the marketing programs affecting farmers. Teachers are reminded that the programs and services offered by the ASCS, in general, are covered in topic H-1.

1. Introduction

Government marketing programs originated with the passage of the Agricultural Adjustment Act of 1933. The objectives of the original Act were to restore farmers' purchasing power, assure adequate supplies of agricultural products, stabilize markets and prices, and equalize farmers' bargaining power. The passage of several amendments have expanded the Federal government's activities in the marketing of agricultural products since the passage of the original Act.

Most of the marketing programs are administered locally by the Agricultural Stabilization and Conservation Service. The ASCS is an agency within the USDA, which is administered by an elected committee of full-time farmers and a county executive director hired by the committee.

Federal farm marketing programs are often criticized by industry spokesmen and private citizens, but the total population benefits. These programs are economic tools which lend stability to the farm sector by leveling out severe swings of high prices one year and disastrous low prices the next. Sharp fluctuations in food production and food prices help no one in the entire food system, least of all farmers and consumers. By using the marketing programs, production can be tailored to the marketplace, adequate food reserves are established, foreign markets are developed, and farm prices are improved. These tools give farmers the flexibility and freedom of operation to decide which crops may be grown the most efficiently.

Transparency No. 1

The U.S. Congress has passed the necessary legislation to enact the programs shown in the above transparency. Authority for administering the different programs is vested in the President, Secretary of Agriculture, and certain departments and agencies within departments.

2. Price Support Programs

Price support programs are administered by the ASCS and are financed by the Commodity Credit Corporation (CCC), a government owned corporation created to stabilize, support, and protect farm income and prices, to help maintain balanced and adequate supplies of agricultural commodities and their products, and to help in their orderly distribution. The CCC has no operating personnel. Its price support, storage, reserve, and diversion program, and domestic acquisition and disposal activities for price-supported commodities are carried out entirely through personnel and facilities of the ASCS. Services of other agencies in the USDA are also used by the CCC.

Commodity support operations are handled primarily through loan, purchase, and payment programs. Wheat, corn, soybeans, cotton, rice, tobacco, milk, milk products, wool, mohair, barley, oats, sorghum, rye, honey, peanuts, flax seed, and gum naval stores are included in the support programs.

A support program is initiated by an ASCS division which prepares a proposal in the form of a document. A document covers economic and other factors upon which the proposal is based. Included are total funds required, proposed method of support, conditions of eligibility, basic operating provisions, and other relative information. When a program is approved, a public announcement, usually in the form of a press release, is issued.

Supports for farm commodities are based on the Food and Agriculture Act of 1977. A "target" price is established for the commodity to be supported. If the commodity price falls below the target price, farmers are paid a deficiency payment equal to the difference between the target price and the national average price or on some other basis. Using corn, sorghum, and barley as example, "the 1980 target prices for these commodities in 1980 were \$2.08 per bushel, \$2.46 and \$2.35, respectively. The feed grain deficiency payment rate was the difference between the target price and the higher of (1) the national average market price received for the first five months of 1980 marketing year or (2) the national average loan rate for the crop involved. The first five months of the marketing year for barley are June-October, and for corn and sorghum, October-February."

Deficiency payments were computed by multiplying the payment rate times the farm's established yield times the number of acres planted for harvest. The resulting figure then is multiplied by the allocation factor which is based on how much the farmer's 1980 planted acreage exceeded the 1979 planted and set-aside acreage.

In order for farmers to qualify for full target price protection, they could not plant more corn, sorghum, or barley in 1980 than was considered planted and set-aside from these crops in 1979. Teachers are probable aware of the severe drought in 1980 which greatly reduced the yields of these grain crops in all of the

Southern states and to some extent in the Midwest. Due to the drought and an increase in exports, grain prices increased beyond the target prices and deficiency payments were not made. Some farmers, however, probably received disaster payments, which is another program.

In order to be eligible to participate in any of the price support programs, the farmer must comply with the provisions of all various programs, which may include set-aside and/or a land diversion payment program, acreage allotments, and marketing quotas.

Transparency No. 2

In reality a number of the programs mentioned above may support the prices of agricultural products; however, the following methods are used solely for supporting prices:

Loans - Price support loans are made directly to farmers through the county ASCS office. The commodity serves as collateral for the support loan. If the commodity is not redeemed by the loan repayment time, the commodity is taken over by the Commodity Credit Corporation. Loans to producers are non-recourse. This means the producers are not obligated to repay the loans or make good any decline in the market price of the commodity they have used as collateral. A producer can deliver or forfeit the collateral to the CCC with settlement of the loan at the loan rate on the quantity and quality involved. Generally farmers forfeit or make delivery of products when prices are below the loan level.

This method provides a great deal of flexibility in marketing farm products. If the price goes down, the farmer uses his product to repay loan. If prices improve, he may sell the product on the open market and repay loan. "The 1980 feed grain and soybean loan rate was \$2.00 per bushel for corn, \$1.90 for sorghum, \$1.63 for barley, \$1.03 for oats, \$1.70 for rye, and \$4.50 for soybeans.

Purchases - Prices of some commodities are supported through purchases of commodities from producers. The CCC is committed to buy eligible commodities from producers, at producer's option, at the support level. This method of support is available on a number of commodities on which loans are available.

Direct Purchases - Some commodities, such as butter, cheese, and nonfat dry milk, are purchased from processors and handles to support prices.

Direct Payment to Farmers - Farmers may receive deficiency payments. These payments are based on the difference between the "target" price and the national average market price or some other factor, and have already been discussed. Production payments are also received by farmers for some commodities.

3. Production Adjustment Programs

Programs have been established to help adjust production and marketing of specific farm crops. Included in these programs are set-aside and other crop diversion provisions, and acreage allotments and marketing quotas.

"These programs are designed to protect and improve farm income, give farmers more opportunity for decision-making on their farms, keep agricultural production in line with anticipated needs, and help assure that both farmers and consumers are equitably considered in the marketplace."

The Secretary of Agriculture is required to provide for a set-aside of cropland if it is determined that the total supply of a commodity will, in the absence of such set-aside, likely be excessive, taking into account domestic and export needs and any additional stocks required to maintain reasonable and stable supplies and prices, and to meet a national emergency. Set-aside provisions are applicable under the same general conditions for each crop. Wheat, feed grains, upland cotton, and rice are crops that may participate in set-aside programs.

If a set-aside is in effect for a commodity, producers must comply with the set-aside provisions in order to be eligible for loans, purchases, and payments. Producers must set aside and devote to approved conservation uses an acreage of cropland equal to a specific percentage of the acreage planted for harvest.

In general, set-aside or diverted acres must be cropland that was tilled in at least one of the last three years, harvested for hay in all three preceding years in rotation with small grain or row crops, or was set aside or diverted acreage the previous crop year. Eligible acres are also approved by the county committee.

In order to provide a basis for limiting the planted crop acreage on a farm whenever a set-aside is in effect, a normal crop acreage (NCA) is established for each farm. A farm's NCA consists of the total number of acres normally planted in 1977 to the following crops: barley, corn, dry edible beans, flax, oats, rice, rye, sorghum, soybeans, sugarbeets, sugarcane, sunflowers, upland cotton, and wheat. Other crops may be included as recommended by the state ASCS committee and approved by the ASCS deputy administrator for state and county operations.

Producers must comply with the set-aside requirements on a farm on which a set-aside crop is planted to become eligible for loans and for deficiency and disaster payments on any program crop they produce on the farm, and for CCC price support loans on any crop included in the NCA.

4. Marketing Quotas and Acreage Allotments

Marketing quotas and acreage allotments are used as means of regulating the marketing of commodities when supplies are excessive. The Secretary of Agriculture proclaims national marketing quotas for designated crops when

supply prospects exceed specified levels. Quotas are in effect only when approved by a two-thirds majority of the eligible producers voting in referendum. If approved, the quotas become mandatory for producers to be eligible for price support.

The national marketing quota for a given commodity represents, in general, the quantity estimated to be required for domestic use and exports during the year. The national marketing quota is prorated to individual farms on the basis of past production history.

The 1980 peanut support program, which had acreage allotments, marketing quotas, and poundage quotas, is given as an example of one commodity.

The 1980-crop national average support levels were \$455 per short ton for quota peanuts and \$250 per short ton for non-quota "additional" peanuts.

The national acreage allotment for 1980 was 1,614,000 acres, which was prorated by states. "Marketing quotas were approved for the 1978-79-80 crops by 94 percent of the peanut growers voting in a December 1977 referendum. Marketing quota penalties apply to peanuts grown in excess of the acreage allotment and also to peanuts marketed or considered marketed in excess of the farm's poundage quota."

The national poundage quota for the 1980 peanut crop was 1,516,000 short tons. Each allotment holder received as a "farm poundage quota" a proportionate share of the national poundage quota. Only quota peanuts were eligible for price supports at the "quota support level."

5. Marketing Agreements and Orders

Marketing agreements were authorized in the Agricultural Adjustment Act of 1933 and have been amended several times in succeeding acts. Marketing agreements establish and maintain orderly conditions to market commodities, provide products at a fair price to the consumer, and provide equitable returns for the producer.

This program differs from other marketing programs in that it combines voluntary and regulatory controls which are established and directed by the industry. Each industry provides the funds for maintaining the program locally.

Marketing agreements are not in violation of antitrust laws and are binding only on those who sign them. Marketing agreements alone are seldom effective. However, if the handlers of agricultural commodities would sign a marketing agreement, it would be necessary to have a marketing order.

A marketing order is mandatory and is issued by the Secretary of Agriculture and binds all the handlers of a commodity. However, a marketing order may be

issued only if two-thirds of the producers of the commodity approve the order by a referendum.

The basic purpose of a marketing order is to provide for the orderly marketing of fruits, vegetables, and dairy products, and to assure a flow of adequate supplies through orderly marketing. Federal milk marketing orders establish minimum prices, based on supply and demand conditions, at which milk handlers or dealers may buy milk from dairy farmers.

Reference:

1. ASCS Commodity Fact Sheets, Agricultural Stabilization and Conservation Service, State Office, U.S.D.A. Building, College Station, Texas 77843.

**SOME PROGRAMS INFLUENCING
THE MARKETING OF
FARM PRODUCTS**

Price Support Programs

Set-Aside

Acreage Diversion

Farmer-Owned Grain Reserve

Acreage Allotments

Marketing Quotas

Marketing Agreements and Orders

METHODS OF SUPPORTING PRICES

Loans

Purchases

Direct Purchases on
Open Market

Direct Payments
to Farmers

AGRICULTURAL MANAGEMENT

Unit G: Marketing

Topic 4: Marketing Cooperatives

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities: Additional information may be secured by obtaining a copy of "Cooperatives ... Self Help At Its Best" from the Texas Federation of Cooperatives, 708 Brown Building, Austin, Texas 78701.

1. Introduction

The history of cooperatives dates back to Colonial days when farmers helped each other clear land, erect buildings, and construct roads. Early cooperatives were informal organizations; but as farmer participation increased and the need for formal organizations developed, cooperatives were organized on a business-like basis. One of the first formal cooperative organizations was a society organized in the 1780's for the purpose of importing purebred cattle and driving livestock to eastern coastal cities. There were some failures in the early cooperatives; but through trial and error, sound principles and techniques have developed.

In the beginning, farm organizations did much to encourage the forming of cooperatives. The Grange, a fraternal organization for farm-families, was a leader in this area. In 1871 there were forty Grange cooperatives operating elevators in Iowa, and there were many more in other states. The Fruit Growers Supply Co. of Los Angeles, California, a well-known cooperative, was one of the first to be organized in this century.

Cooperatives have made many changes in their operations since World War II. Mergers, expansions, integrations, and contractual agreements have played a part in these changes.

A cooperative cannot be identified by its name, as they are called various names in different parts of the country. Associations, co-ops, exchanges, societies, service companies, and bargaining associations are some of the most commonly used names. Cooperatives can also be identified by the services they perform.

A cooperative is a business voluntarily owned and controlled by its member patrons, and operated for them and by them on a cost basis. It is a business owned by the people who use it. It is organized and incorporated to engage in economic activities, while maintaining the ideals of democracy, social consciousness, and human relations. A cooperative provides services and benefits for its members in proportion to the use they make of their organization, rather than earning profits for the shareholders as investors.

A cooperative is part of the free enterprise, competitive, capitalistic system and is not a government sponsored welfare agency or a charitable and benevolent society. It depends upon income earned from rendering services to meet its expenses, rather than upon donations, government handouts, or support from philanthropic organizations.

Transparency No. 1

The purpose of a cooperative is to serve its members in a way that will enable them to realize higher incomes, lower costs, or more efficient and dependable services. Membership in a cooperative offers the advantages listed in Transparency No. 1.

Ordinarily, the marketing power of an individual cannot compare to that of a cooperative where large quantities are assembled and marketed. Often several cooperatives will market products jointly.

Cooperatives have built a reputation for quality, and many of the famous brands in the U.S. are advertised by farmer cooperatives. Combining the resources of their members, cooperatives can do a much better job of grading, processing, handling, and merchandising, because research can be conducted on new products and markets to find other uses for farm commodities. Cooperatives participate in food fairs and trade promotion and are able to market products on a national and international scale.

2. Business Procedures

Operating in a businesslike manner, cooperatives follow general business rules and conform to laws and regulations that govern other businesses. Cooperatives have three distinguishing characteristics: they are a democratic organization controlled by members who have a voice (one vote per member) in the operation of the business; they operate at cost; and they provide a limited return on capital investment.

Transparency Nos. 2 and 3

There is considerable variation among cooperatives. Some are small with only a few members, while others are large regional cooperatives that serve farmers in several counties. The different types of cooperatives are discussed below.

Types of Cooperatives

The local cooperatives are the most numerous. Local cooperatives provide services to a town, county, or several counties. It may or may not be affiliated with regional or national cooperatives.

Another type is regional or national cooperatives. These may be described as a cooperative of cooperatives. They serve a relatively large geographic area, such as several counties, an entire state, or a number of states. When several large regional cooperatives combine to form a large interregional association serving many states, the association becomes a national cooperative. There are two types of regional cooperatives based upon their membership structure. These are federated and centralized.

Local cooperatives have found that by joining together and forming regional federations they can increase their purchasing and bargaining power and maximum efficiency. When a local cooperative becomes a member of a federation, it remains a separate entity but is said to be affiliated with the regional.

Federated cooperatives are owned by the local cooperatives in which they serve. The federation may have subsidiaries, but the federation and subsidiaries are also owned by the local cooperatives. Federated cooperatives have a manager and staff which are hired by a board of directors elected from member-locals. The members who own the local cooperatives, through their elected representatives, own and control regional and national cooperatives.

3. Organizing a Cooperative

Cooperatives have four basic principles of operation. When one or more of these principles are not observed, the association ceases to be a true cooperative in the strictest tradition.

The first principle is open membership. Anyone needing the services offered and can accept the responsibility of membership is generally permitted to become a member. Membership may be either through the purchase of stock, or in the case of a non-stock cooperative, a membership certificate. Participation, ownership, and control are without restrictions and discrimination.

The second principle is democratic control. The membership, rather than a member's investment, is the basis for voting. The affairs of the cooperative are administered by people elected or appointed in a manner agreeable to the membership, and these people are accountable to the membership.

Principle number three is limited returns on shared capital. This principle is important in maintaining the true objectives of the cooperative, to provide goods and services rather than a large return on invested capital. Member capital invested in a cooperative is paid a fixed rate of dividends for its services, which is generally limited by State or Federal statutes to eight percent or less.

The fourth principle is net savings will be returned to members in proportion to their patronage. This is an important principle, in that it distinguishes cooperatives from other forms of businesses. Surplus or savings, if any, arising out of the operation of a cooperative belong to the members and should be distributed in such a manner as to prevent one member from receiving advantages not enjoyed by others.

Since most cooperatives are corporations, they follow the same procedures for incorporating as other businesses. To incorporate, a firm prepares articles of incorporation and sends them to the appropriate state office for review. The articles of incorporation specify the name of the organization, its purpose, scope of authority, business address, number of directors, and whether the capital is stock or nonstock.

In addition to the articles of incorporation, the cooperatives must have a set of bylaws which explain operating procedures. Bylaws usually include provisions for membership eligibility, election of directors, the time of the annual meeting, duties of officers, voting rights, dues and assessments, and dividend rates.

There are four groups of people involved in a cooperative: directors, manager and key assistants, clerical and operating employees, and member-patrons. Directors are elected by the membership at the annual meeting, and are responsible to the members. They hire the manager and develop business policies. The cooperative manager and his staff determine the procedures for executing the objectives of the cooperatives, subject to directors' approval. Clerical and operating employees are supervised by the manager and his key assistants. Their responsibilities are outlined in staff meetings and training programs. The member-patron is the foundation on which the cooperative is built. Their support, through patronage and capital investment, keeps the cooperative economically healthy.

4. Financing Cooperatives

Cooperatives are usually financed by two methods, capital stocks or membership contributions. If the cooperative is a capital structure, it is financed through the sale of stock certificates to members. Stocks are of two kinds, common and preferred. Stock cooperatives usually issue one common share of stock per member, and preferred stock is issued to members who have made additional capital contributions. Common stock is voting stock, while preferred stock is non-voting. Sources of capital for cooperatives may be secured from members, non-member patrons, individuals, firms, supply companies, cooperative banks, commercial banks, and other cooperatives.

Non-capital cooperatives usually issue certificates to show that members have made a capital contribution to the cooperative.

Cooperatives have been of tremendous value to the farmer. The 8,500 farmer cooperatives in the U.S., market approximately twenty-five percent of all agricultural products and provide about twenty percent of all farm production supplies used on farms.

References:

1. "Cooperatives in Agribusiness," Farmer Cooperative Service, U.S. Department of Agriculture, Ed. C-33.
2. "How to Start a Cooperative," Farmer Cooperative Service, U.S. Department of Agriculture, Ed. C-18.
3. "Agricultural Cooperatives," Farmer Cooperative Service, U.S. Department of Agriculture, B-4.

ADVANTAGES OF COOPERATIVES

Add Marketing Strength

Quality Products

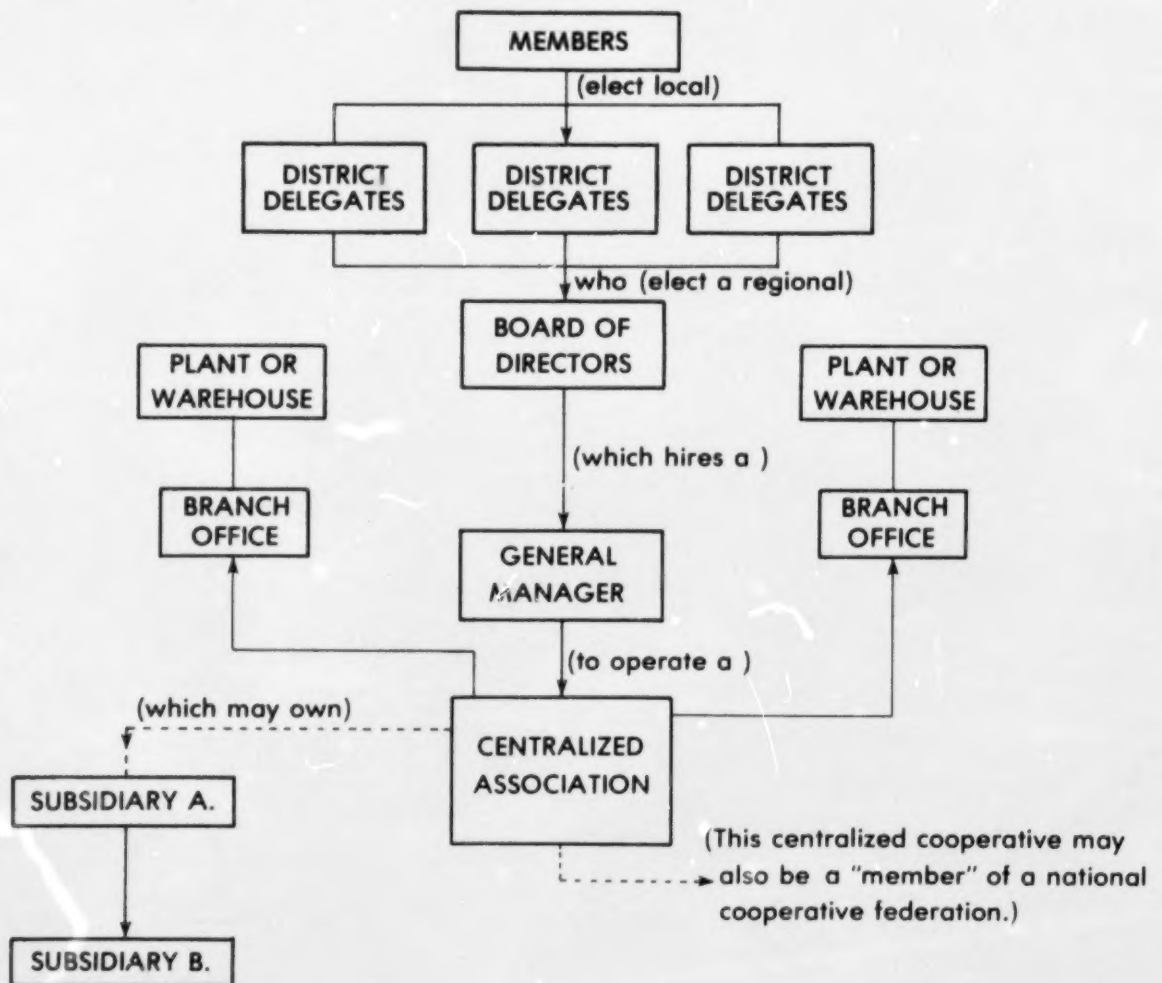
Improve Merchandising

Provide Processing Services

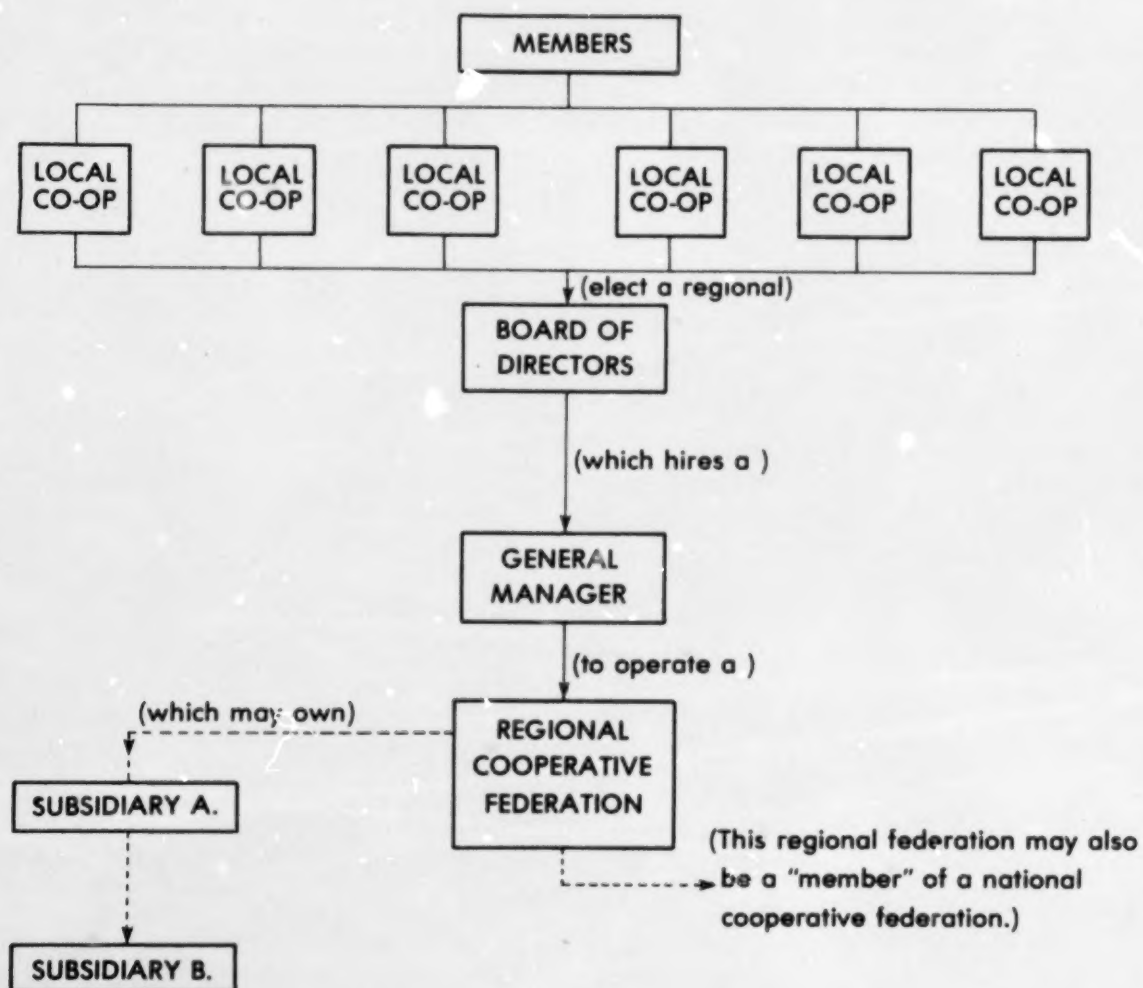
Research and Improve Technology

Larger Marketing Area

STRUCTURE OF A REGIONAL COOPERATIVE



STRUCTURE OF A COOPERATIVE FEDERATION



AGRICULTURAL MANAGEMENT

Unit H: Agricultural Programs and Services

Topic 1: The United States Department of Agriculture Programs and Services

Note: All terms underlined are included in the "Glossary of Terms."

Suggestions and Activities: The vocational agriculture teacher may wish to secure the services of the administrators of the local USDA agencies to explain the programs and services offered by their respective agencies.

Since the marketing of agricultural products is of utmost importance, the teacher may wish to secure the "Federal-State Market News Reports - A Directory of Services Available" from the Agricultural Marketing Service, USDA, Washington, D. C. 20250.

1. U. S. Department of Agriculture (USDA)

In 1862 during the second year of his administration, President Lincoln signed into law the act establishing the USDA. A number of early American leaders had envisioned such a department. George Washington in 1796 had urged the creation of a national board of agriculture. Thomas G. Clemson of South Carolina in 1861 developed a plan of work for a Department which emphasized the need for agricultural experimentation. Although the initial legislation was very broad, one of the specific duties outlined was to acquire information by practical and scientific experiments.

Three other acts signed at the time the Department of Agriculture was created were the Homestead Act, Transcontinental Railroad Act, and the Morrill Land Grant College Act. Although all three Acts were of great importance, the Morrill Land Grant College Act, which granted land to each state for colleges of agriculture and mechanic arts, is still making a great contribution to the country and the world through teaching and research.

The USDA today has numerous agencies and over 145,000 employees dealing with the complex problems of agriculture. A complete listing of the services offered by each agency in the USDA is impossible in the space allocated; however, a discussion is given on the general responsibilities of a number of agencies.

2. Agricultural Stabilization and Conservation Service (ASCS)

The forerunner of the ASCS was the Agricultural Adjustment Administration (AAA), which was established by Congress in 1933 for the purpose of restoring farm prices and the farmers' purchasing powers. After several name changes (Production and Marketing Administration in 1945, and Agricultural Stabilization and Conservation

Committee in 1954), the agency was designated the ASCS in 1961.

The ASCS is administered by a system of committees. State committees are composed of three to five members, appointed by the Secretary of Agriculture, and responsible for the administration of farm programs in each state and the general supervision of county committees. Each state committee appoints a state executive director, who supervises and directs the work of the state office staff under policies established by the committee.

County or community ASCS committees are responsible for administering local programs. These committees consist of three regular members, serving a staggered three-year term and two alternate members, elected by the farmers in the county or community. Committee members are full-time farmers. The county extension agent is a non-voting ex officio member of the county committee. There are some 3,000 county committees, one for each "agricultural county" in the nation, and 16,000 community committees. ASCS county committees employ a county executive director who, for the committee, hires the necessary employees to staff the county office.

Transparency No. 1

Changing conditions in agricultural practices and production along with the demand for certain agricultural products require that changes be made periodically in the objectives of the ASCS programs. Present objectives of the ASCS are shown in the above transparency, while its responsibilities are shown in the one below.

Transparency No. 2

3. Commodity Credit Corporation (CCC)

The CCC is a government owned corporation, chartered under the laws of the state of Delaware in 1933. It was created to stabilize, support, and protect farm incomes and prices; help maintain balanced and adequate supplies of agricultural commodities and their products - foods, feeds, and natural fibers - and help in their orderly distribution. Basic responsibilities of the CCC are shown in the following transparency.

Transparency No. 3

Management of the CCC is entrusted to a board of directors, subject to the general supervision and direction of the Secretary of Agriculture, who is an ex officio director and chairman of the board. Being appointed by the President of the U.S. by and with the advice and consent of the senate, the board is composed of seven members, in addition to the Secretary of Agriculture. Members of the board are all officials in the USDA.

The CCC has no operating personnel. Its price support, storage, reserve and diversion program, domestic acquisition, and disposal activities for price-supported commodities are carried out entirely through the personnel and facilities of the ASCS.

Other agencies in the USDA also provide services for the CCC. The Agricultural Marketing Service supervises the bonding of federally licensed warehouses and inspects all warehouses used by the CCC. The Food Safety and Quality Service utilizes various commodities acquired by CCC under price support operations and also is responsible for acquisition of food items for domestic food programs. With the exception of tobacco, peanuts, and gum naval stores, the Foreign Agricultural Service administers export sales and foreign assistance disposal of CCC-controlled stocks.

CCC's capital stock of \$100 million is held by the U.S. Government. Under present law, up to \$20 million may be borrowed from the U.S. Treasury to finance operations. Each year the CCC submits in the U.S. budget its proposed programs for the coming fiscal year. Upon the approval of the budget by Congress, this becomes the basic operating plan of the Corporation for that period.

4. Farmers Home Administration (FmHA)

The FmHA was established by Congress in 1946 and replaced the Federal Emergency Relief Administration, a rural rehabilitation program established in 1934. The FmHA is administered through a state director and a system of area officers. The area office is under the direction of a supervisor. An area committee, composed of individuals from each county in which the area office serves, has the responsibility of directing the activities of the supervisor, recommending debt settlement, and determining the eligibility of applicants and the value of property.

Transparency No. 4

The agency was created to help farmers by making higher risk loans than those that are considered justifiable by other lending agencies. Farm loans continue to occupy a key role in the agency's authorities; however, the scope has broadened to allow for loan authority for literally any type of project that will build economic strength or improve the attractiveness, living conditions, and value of small towns and rural areas.

Maximum farm ownership loans made by FmHA cannot exceed \$200,000, although FmHA can guarantee loans as high as \$300,000 from other sources. The interest rates charged for FmHA loans are based on the rate of current government borrowing. Repayment terms can be up to 40 years. Interest rates and repayment terms for guaranteed loans are negotiated between borrower and lender, with FmHA guidelines.

Farm operating loans made by FmHA may not exceed \$100,000; however, the agency can guarantee loans to farmers from other credit sources as high as \$200,000. Operating loans are to be repaid over a period not exceeding seven years, but extensions are sometimes granted. Interest rates are set each year by the U.S. Treasury and the Secretary of Agriculture.

Loans are also made by the FmHA to public bodies and private nonprofit corporations for rural development projects including irrigation, drainage, soil and water conservation facilities, and grazing associations. Financial assistance is available for community facilities, including water and waste disposal systems, for public use in rural areas and towns up to 10,000 population. Many other kinds of loans are also made.

5. The U.S. Forest Service

The U.S. Forest Service was established by the Agriculture Appropriation Act of 1906. Prior to its establishment, the functions of the Forest Service were performed by other agencies.

USDA's Forest Service administers 188 million acres of national forest and grasslands. It cooperates with state foresters, private owners of forest lands, and wood processors in providing advice on management and use, provides assistance to private landowners, and conducts research to support these activities.

The ASCS in cooperation with the U.S. Forest Service and the Texas Forest Service provides cost-sharing funds to private landowners for woodland management practices. Funds are shared up to a cost of 75 percent. Participation is limited to landowners with a maximum of 1,000 acres of forest land.

Assistance is provided by the Forest Service for tree planting, timber stand improvement, timber sales, and other woodland activities affecting some 5.7 million acres of timberland. State nurseries in 1978 distributed 655 million seedlings for use in forest and windbarrier plantings. In addition, Federal nurseries distributed 126.5 million seedlings.

The largest forestry research program in the world is administered by the U.S. Forest Service. At sites operated by eight forest experiment stations and the Forest Products Laboratory, research projects covering every aspect of forest management, protection, and utilization are under way.

America's forest lands now occupy about 740 million acres, one-third of the nation's 2.3 billion acres of land. National forests occupy 183.2 million acres. Of this amount, 89 million acres or 18 percent of the nation's total is commercial forest land. Private forests make up about 58 percent, and the remainder is owned by commercial firms and other government agencies.

Transparency No. 5

The Forest Service has the responsibility of promoting and conserving the nation's forests. Most farmers are eligible to receive their services.

The Texas Forest Service (TFS), headquartered at Texas A&M University, was established by legislation passed in 1915. The objectives of the TFS are to cooperate with the U.S. Forest Service and assure an indefinite and adequate supply of timber.

6. Soil Conservation Service (SCS)

The passage of the Flood Control Act in 1927 was the first legislation dealing with the conservation of soil. Federal appropriations for soil conservation was first provided in 1928. These funds were used for soil conservation research. In 1935, the SCS became an agency of the USDA. Several acts affecting the SCS have been enacted since the original act.

Transparency No. 6

There are approximately 2,950 local conservation districts in the U.S., which cover an area about the size of a county. Districts are organized by local citizens and operate under an elected board of supervisors. A district conservationist supervises the work of technicians and office personnel.

In order to receive the technical assistance available from a SCS district, a landowner or farmer must make application and receive board approval for membership. After becoming a member, a long-range conservation plan is developed, with landowner assistance, by the district technicians. Usually several years are required to complete the plan. After all conservation practices have been established on a farm, they must be maintained.

7. Federal Crop Insurance (FCIC)

The Federal Crop Insurance Corporation, a government owned corporation, was created by law in 1938. Heavy expenditures by the Federal Government for emergency assistance during the 1930's provided the stimulus for its creation. The original law covered only the insurance for wheat; however, the Federal Crop Insurance Act of 1980 will expand the coverage to all major commodities in all counties by 1985.

Generally covered are unavoidable losses of production due to drought, excessive moisture, insects, diseases, hurricanes, tornados, or any loss due to natural hazards beyond the farmer's control. Some of the advantage of having crop insurance are shown in the following transparency.

Transparency No. 7

Several options (price per bushel, percentage of normal yields, etc.) are available to the farmer when he insures his crop. Premium cost is determined by the option selected by the farmer. After the crop is planted, the farmer reports the number and location of acres planted. He is expected to report any serious damage to the crop during the growing season. After harvesting the crop, production is reported if it is less than the amount guaranteed by the insurance policy.

Accurate records of production must be kept by the farmer. If losses occur, an adjuster, who is or has been a farmer, measures the acreage, verifies the production, and determines the cause of loss. If the loss was due to neglect, poor farming practices, or some other uninsured cause, the Corporation is not expected to pay for the loss. A detailed explanation of Federal Crop Insurance is given in Topic F-4.

8. Agricultural Marketing Service (AMS)

The passage of the AMS Act in 1946 provided the authority for its many functions. Several divisions are included in the AMS' area of responsibility. Some are the Federal-State Market Improvement Program, Food Merchandising Assistance, USDA Grading Programs, and Federal-State Market News Service.

The Federal-State Market News Service, a cooperative effort between the AMS and the State Department of Agriculture, provides an invaluable service to farmers and handlers of farm products. The reports published by the Service provide accurate, unbiased, up-to-the-minute information on the supply, demand, prices, and movement of agricultural products. With a knowledge of supply and demand conditions, farmers have more bargaining power and can plan their marketing.

Market reports are prepared in field offices under the direction of the AMS commodity division in Washington. Most field offices cover only the products assigned to the commodity division of which they are a part. They report on commodities in their markets and provide summaries from other markets important to those patronizing the local market.

Radio and television stations, newspapers, trade papers, and other news media may obtain market news reports through direct contact with the market news office, through regularly mailed market news reports, by dialing special telephone numbers for recorded messages, or from commercial news wire services. The farmer may also receive the market news report by requesting that his/her name be included on the mailing list. The request should be sent to the Texas Department of Agriculture, P.O. Box 12847, Capitol Station, Austin, Texas 78711.

Transparency No. 8

There are several crop reporting districts in the State of Texas. The number varies depending on the crop. When a person asks to receive the weekly crop report, the district developing the report should be designated. The address of the Crop and Livestock Reporting Service is P.O. Box 70 Austin, Texas 78767.

9. Foreign Agricultural Service (FAS)

The FAS promotes commercial exports by conducting market development programs abroad in cooperation with agricultural export trade associations. A wide variety of commodities are represented by associations. The FAS works with 50

of these associations, which in turn work with approximately 1,600 overseas organizations, 1,500 U.S. cooperatives, and 8,700 private U.S. firms. The FAS also works with the departments of agriculture in the 50 states.

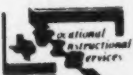
Two basic approaches are used in market promotion: one is trade servicing, helping the buyer choose the right U.S. product and using it efficiently. Trade servicing encourages the use of bulk, unprocessed commodities such as soybeans and feedgrains. The other approach is direct promotion. Cooperators and state groups promote and represent semiprocessed and processed products.

FAS sponsors overseas trade shows featuring U.S. food products. In-store promotions are conducted and sales teams visit foreign buyers. The FAS also maintains a Trade Opportunity Referral Service in which foreign buyers may request firms handle a particular agricultural product.

FAS maintains trade offices throughout the world to service foreign export markets in major or emerging trade areas. Location of some of the trade offices are Seoul, Korea; London, England; Hamburg, West Germany; Manama, Bahrain; Singapore; Warsaw, Poland; and Miami, Florida (serving the Caribbean and Latin America).

OBJECTIVES OF THE ASCS

- *Help assure farmers and ranchers a fair financial return from their operation;*
- *Provide agricultural producers protection against severe declines in market prices;*
- *Assist farmers and ranchers struck by natural disasters;*
- *Assure consumer of an abundance of food and natural fiber;*
- *Encourage price stability and reliable supply through a producer-owned and controlled food reserve;*
- *Encourage production beyond domestic food, feed, and fiber needs for servicing the export market and world relief programs;*
- *Conserve and protect the nation's agricultural resources through cost-sharing conservation measures with farmers and ranchers;*
- *Maintain a state of readiness to carry out food and agricultural programs under wartime conditions.*



ASCS RESPONSIBILITIES

- ✓ Commodity support operations through
 - a. loans to farmers
 - b. direct purchase of commodities from farmers and processors
 - c. production payments for wool and mohair
 - d. payments for crops if prices fall below "target price"
- ✓ Administration of a farmer-owned grain reserve program
- ✓ Production adjustment to balance supply and demand for specific commodities through set-aside and acreage diversion
- ✓ Management of Commodity Credit Corporation inventories when acquired under commodity programs
- ✓ Disaster activities to augment feed supplies for farmers and ranchers in areas where natural disasters have reduced feed, and emergency conservation assistance in restoring farmland seriously damaged by flood, drought, or natural disaster
- ✓ Resource conservation and environmental protection assistance through cost-sharing with farmers and ranchers

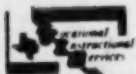
CCC RESPONSIBILITIES

- * Support prices of agricultural commodities through loans, payments, purchases, and other operations*
- * Make available materials and facilities required in the production and marketing of agricultural commodities*
- * Procure agricultural commodities for sale to other government agencies, foreign governments, and domestic, foreign, or international relief or rehabilitation agencies*
- * Dispose of, or aid in the disposal of, surplus agricultural commodities*
- * Assist in the development of new domestic and foreign markets and marketing facilities for agricultural commodities*

OBJECTIVES OF THE FmHA

To provide credit, financial and management assistance to farmers, rural communities, and public agencies in rural areas to:

- Develop, operate, and purchase family farms*
- Build homes and farm buildings*
- Develop recreational facilities, community water supply, and waste disposal systems*
- Build houses for domestic farm laborers*
- Build rental housing for the elderly*
- Develop, conserve, and utilize natural resources*
- Farmers who suffer loss of income, property, and crops due to natural disasters*
- Raise and maintain income and living standards of low-income families*



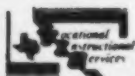
OBJECTIVES OF THE U.S. FOREST SERVICE

Protect and Prevent Forest Fires

**Produce and Distribute Forest
Tree Nursery Stock**

**Provide Technical Assistance on
Forest Management**

**Cooperate with Others in
Conserving the Forest and Other
Natural Resources**



SERVICES PROVIDED BY THE SCS

Technical Assistance to:

- a. Farmers, Ranchers, and other Individuals and Groups*
- b. Local and state governments to reduce erosion and sedimentation, conserve water and improve water quality, reduce energy requirements, and plan better land and water uses*
- c. Sponsoring groups in planning and installing small watershed protection projects*

National Cooperative Soil Survey

Provides Conservation Assistance to Current Mining Operations

Reclamation of Abandoned Mines

River Basin Surveys and Investigations

Helps in Postflood Restoration

Assists Schools in Planning and Building Outdoor Conservation Classrooms



ADVANTAGES OF FEDERAL CROP INSURANCE

Eliminates Some of the Crop Risk

Insurance May Serve as Security for Credit

Stabilizes Income

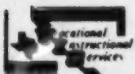
Insurance Can Be Adapted to Farmer's Needs

30 Percent of Premiums are Paid by Government

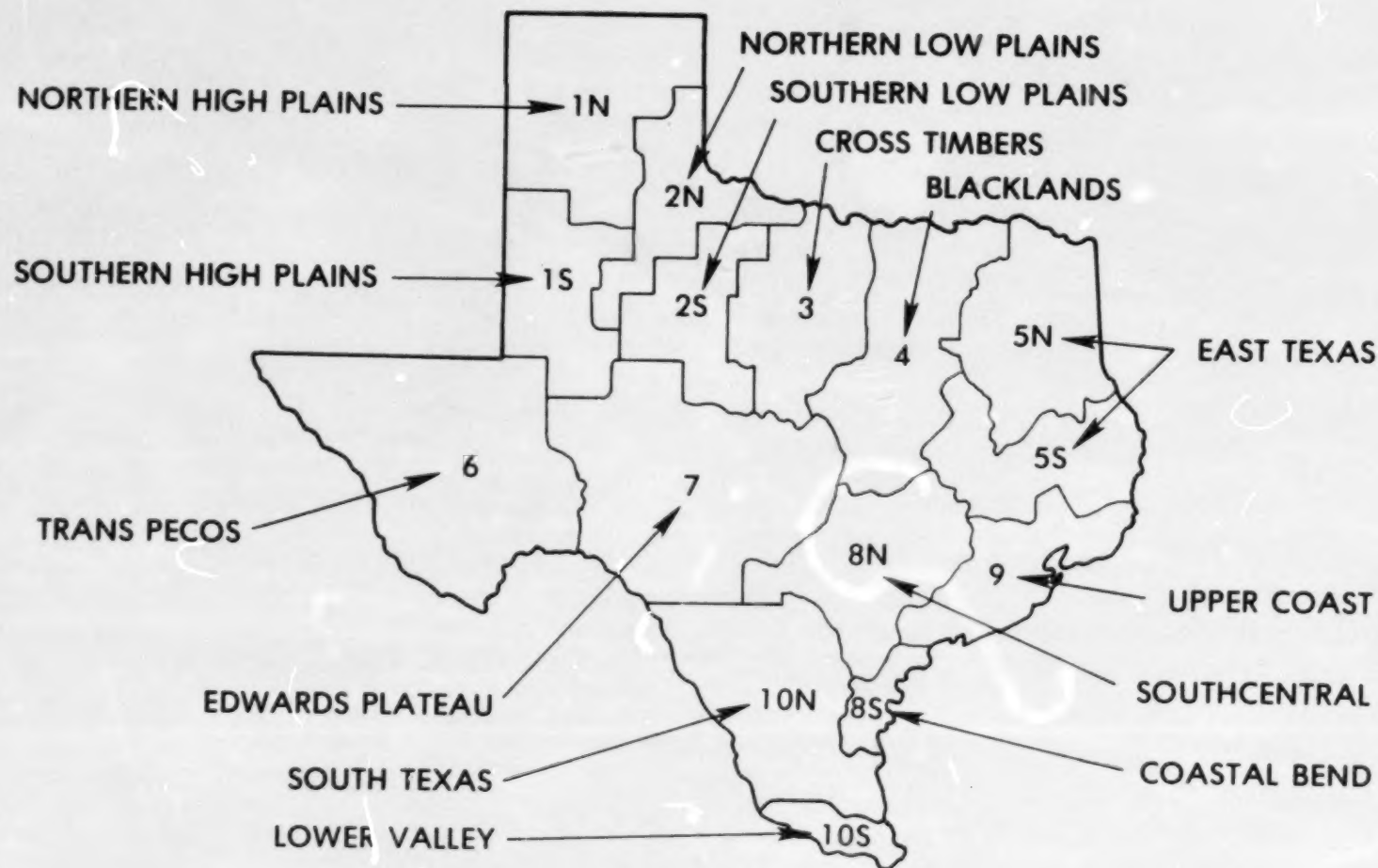
Less Need for Capital Reserve

Guarantees Hedge for Forward Contracting

Most All Crops Can Be Insured By 1985



TEXAS CROP REPORTING DISTRICTS



AGRICULTURAL MANAGEMENT

Glossary of Terms

1. Joint Account - A bank account of two people, man and wife or father and son.
2. Set-Aside Acreage - Acreage which has been taken out of a specific crop in order to participate in an ASCS program.
3. Comparative Advantage - The placing of emphasis and efforts in the area where the greatest returns will be realized.
4. Marketing Agreements - A voluntary contract between an Agency of the USDA and a handler of an agricultural product.
5. Acreage Allotments - The number of acres a farmer can plant to a specific crop and participate in an ASCS program. The acreage allotment is usually based on the number of acres planted to a specific crop for a number of years.
6. Current Assets - Assets such as cash on hand, bills receivable, and other items that may be converted to cash immediately.
7. Fixed Assets - Assets that cannot be converted to cash immediately. Land, barns, and fences are examples of fixed assets.
8. Bankruptcy - A state of being bankrupt and declaring such.
9. Bearer - The person holding the check or draft for payment.
10. Industrial Accident Board - A board appointed for the purpose of reviewing and approving claims under the Workmen's Compensation Insurance Law.
11. Complete Budget - A budget for the entire farming operation or business.
12. Enterprise Budget - A budget prepared for a specific agricultural enterprise.
13. Family Living Budget - A budget of the family's living expenses.
14. Partial Budget - A budget for a small part of the business.
15. Operating Capital - The amount of capital used to operate a business.
16. Working Capital - Capital that is used to operate a business or from which a person is receiving some returns.
17. Credit Card - A card which authorizes credit purchases.

18. Check - A written order on a bank and payable on demand to the person named or to the bearer.
19. Certified Check - A check that has the word "certified" stamped across its face by the bank on which it was drawn. The bank must assume the responsibility for its payment.
20. Assignment Clause - A clause in an insurance policy that transfers the rights under the policy to a third person.
21. Travelers Checks - Drafts issued by a bank or express company payable on presentation by any correspondent of the issuer.
22. Deductible Clause - A clause in an insurance policy that specifies that the policy holder will pay a portion of the total claims.
23. Collateral - Security offered as a guarantee for repayment of a debt.
24. Federated Cooperative - A group of cooperatives receiving goods and services from a single source (cooperative) which was organized for this purpose.
25. Fixed Costs - Those costs that occur regardless of production.
26. Operational Costs - Expenses incurred in operating a farm or business.
27. Original Cost - The cost of an item when it was first purchased.
28. Marginal Cost - The change in total cost, or total variable cost, due to one-unit change in output.
29. Principle of Opportunity Costs - It is also known as the equal added return principle and is determining the greatest added returns from a combination of enterprises from each available unit of capital, labor, and land,
30. Production Costs - The value of the resources used to obtain output.
31. Total Cost - The sum of the cost of variable inputs and the cost of the fixed inputs at any given level of production.
32. Credit - A means of obtaining goods or services now by promising to repay at a later date.
33. Consumption Credit - Credit obtained for the purpose of purchasing household items used by the family.
34. Production Credit - Credit obtained for the purpose of maintaining or increasing production.

35. Debits - Charges against an account.
36. Depositor - A person who makes a deposit to an account.
37. Depreciation - A decrease in value of an item due to age or wear.
38. Annual Revaluation Method of Depreciation - The item is evaluated annually and the present evaluation is subtracted from the preceding evaluation to determine the amount of depreciation.
39. Diminishing Balance Method of Depreciation - A fixed amount of the value of an item is depreciated each year until the salvage value is reached.
40. Straight-Line Method of Depreciation - A method of figuring depreciation by dividing the original cost of an asset, less salvage value, by the number of years the asset is expected to last.
41. Sum-of-the-Digits Method of Depreciation - A method of depreciation that is determined by multiplying a fraction times the amount to be depreciated.
42. Diminishing - Decreasing
43. Draft - Similar to a check but instead of being charged to a signer it is charged to a third person named on the face of the draft.
44. Endorsements - A provision added to an insurance policy.
45. Fixed Expenses - Expenses that do not change with output. Examples are taxes and depreciation.
46. Operating Expenses - Expenses incurred in the business operation.
47. Gross Income - Total of all receipts from a project before expenses are deducted.
48. Net Cash Income - The cash income after the cash expenses are deducted from the gross cash income.
49. Net Farm Income - The farm income left after expenses are deducted from gross income.
50. Input - A factor of production or basic resource; it may be fixed or variable in nature.
51. Fixed Input - A factor whose quantity is given and not subject to variation by the producing unit during the time period in question.

- 52. Credit Instrument - An instrument used to obtain credit.
- 53. All Risk Insurance - An insurance policy written by the Federal Crop Insurance Corporation that guarantees the farmer an amount per acre that is equal to his cash expenses.
- 54. Term Life Insurance - A type of life insurance which covers the policy holder for a specific period of time. At the end of the term, the coverage stops and the policy has no cash value.
- 55. Interest - The cost of borrowing money.
- 56. Insurable Interest - The interest or equitable rights owned or partially owned by an individual or firm.
- 57. Safe Investments - An investment which will not decrease in value.
- 58. Speculative Investments - An investment on which the buyer expects to profit from an increase in price. There is always the possibility, however, that the price will decrease.
- 59. Bill of Lading - A contract or receipt signed by a common carrier who agreed to deliver freight to a given person.
- 60. Lender - A person or firm who lends money.
- 61. Current Liabilities - A debt that is due or will be due shortly.
- 62. Intermediate Liabilities - Liabilities which will be due within the next six years.
- 63. Long-Term Liabilities - Liabilities that will be due within the next seven to thirty years.
- 64. Public Liability - The responsibility of the owner for the safety of a person on his property, whether the person is trespassing with or without owner's consent.
- 65. Lien - A claim on the property of another as security against the payment of a debt.
- 66. Mechanic's Lien - A claim or lien against real estate on which labor, lumber, hardware, or other construction materials have been provided.
- 67. Vendor's Lien - A lien given in equity to a vendor of land or other real estate for unpaid purchase money.
- 68. Automatic Loan - A provision in an insurance policy where the insurance company pays the premiums and charges it against the policy as a loan.

- 69. Installment Loan - A loan being repaid over a period of time. Payments are usually of equal amounts and include interest.
- 70. Intermediate Loans - Loans made for a period of two to six years.
- 71. Long-Term Loans - Loans made for a period of seven to thirty years.
- 72. Short-Term Loans - Loans made for less than two years.
- 73. Signature Loans - A loan requiring only the signature of the borrower as collateral.
- 74. Agricultural Management - The decision-making involved in planning, directing, and controlling an agricultural business.
- 75. Domestic Market - A market within the boundaries of the United States.
- 76. Foreign Market - A market outside the boundaries of the United States.
- 77. Marginal - Added or additional
- 78. Accrual Method - A method of accounting where income and expenses are credited to the year in which they are made.
- 79. Cash Method - A method of accounting where income is credited to an account in the year in which it is received, and the expenses are deducted in the year in which they are paid.
- 80. Middleman - A person between the producer and the consumer who handles a product.
- 81. Mortgage - A legal document that lists specific property which has been set aside to guarantee payment of a debt.
- 82. Chattel Mortgage - A mortgage on movable property.
- 83. Real Property Mortgage - A specific listing of real estate set aside to guarantee payment of a debt.
- 84. MC = MR - Marginal costs equal marginal returns.
- 85. Promissory Notes - A negotiable instrument which is legal evidence of a debt contracted by a borrower from a lender.
- 86. Marketing Order - An order which affects every handler of a specific agricultural product and is issued by an agency of the USDA.

87. Output - Unit of production resulting from the combination of variable and fixed inputs.
88. Payee - The person to whom a payment is made.
89. Land Diversion Payment - A payment made to farmers by the ASCS for diverting acres from a crop.
90. Balloon Payment Plan - A payment plan whereby the interest is paid at designated times, but the principal is paid in a lump sum.
91. Decreasing Payment Plan - A plan whereby a fixed amount of principal is paid each year plus interest on the unpaid balance. The payments are larger at the beginning of the payment period than at the end because of the interest that is due.
92. Equal Payment Plan - A plan where equal payments are made throughout the life of the loan.
93. Group Insurance Plan - A plan for insuring a group of animals or people.
94. Optional Prepayment Plan - Is a contract which permits the lender to pay all or part of a loan at any time without penalty.
95. Lapsed Policy - An insurance policy which is not in effect because premiums were not paid.
96. Livestock Mortality Policy - An insurance policy protecting the owner of an animal against loss by death of the animal.
97. Portfolio - Securities owned by an investor.
98. Factors of Production - Are land, labor, capital, and management.
99. Profit - The excess returns over expenditures.
100. Cash Flow Projection - An estimate of the timing and amounts of income and expenses.
101. Marketing Quotas - Quotas established by the ASCS as to the amount of a product that may be sold from a certain acreage. A pricing system may also be included.
102. Capital Ratio - Is determined by dividing total assets by total liabilities. The farmer can use the ratio to compare the present condition of his business with another date.
103. Receipts - Cash or value received

104. Warehouse Receipt - A receipt given by a warehouse firm for goods stored in a warehouse. They are sometimes used as collateral for loans.
105. Enterprise Records - Records kept on a single enterprise.
106. Reinsurability - Proving that an animal or person is worthy of insurance before renewing an insurance policy.
107. Capital Resources - Is the amount of capital available to an individual from different sources.
108. Fixed Resources - A factor of production which does not vary with units of total production such as a single acre of land.
109. Diminishing Economic Returns - Is closely related to diminishing physical returns, and the difference is that values are assigned in terms of dollars and cents.
110. Diminishing Physical Returns - A decrease in the marginal output with each additional unit of input.
111. Law of Diminishing Returns - Applies to problems of farm production and assists in determining the amount of capital labor and other resources to secure maximum production with the largest net returns.
112. Net Returns - The financial returns after all costs have been paid.
113. Equitable Rights - Having certain rights because of the ownership of a certain equity.
114. Speculative - To assume a risk in business in the hope of gain.
115. Pro-Forma Financial Statement - A statement projecting the net worth position of the farm if everything occurs as planned.
116. Income Statement - A statement showing the income derived from a business.
117. Pro-Forma Income Statement - A statement projecting the income of a farm if everything occurs as planned.
118. Resource Substitution - The substituting of one resource for another.
119. Double Entry System - A bookkeeping system that requires two entries for each transaction.
120. Marketing System - The complex system used to market agricultural products.
121. Single Entry System - A bookkeeping system requiring only one entry either as an expense or income.

- 122. Cash Value - The amount of cash a policy-holder would receive if the insurance policy was surrendered.
- 123. Calendar Year - A period from January 1 through December 31 of the same year.
- 124. Fiscal Year - May be a twelve months period ending any month except December.